,H I S T O S:

THE DEVELOPMENT AND IMPLEMENTATION OF A BIOLOGICAL LAB PROGRAM,

MASTER'S PROJECT

Submitted to the School of Education
University of Dayton, in Partial Fulfillment
of the Requirements for the Degree
Master of Science in Education

by

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CHAPTER I

INTRODUCTION

This project addresses those heretofore limited experiments and laboratory activities associated with a secondary biology course having a core emphasis on human anatomy and physiology. Such a course has been offered at Oakwood High School for nearly two decades. It offers labs to students in two distinct, yet related areas. Anatomy labs provide students with a wide variety of dissectable materials. Whole specimens as well as individual organs are examined and analyzed. In association with lectures, demonstrations, and AV presentations, these labs present a series of unique and critical opportunities in the study of human macroscopic structure. Physiology labs center upon functional aspects of the human organism and can involve the biochemical analyses of real or simulated body fluids such as blood, urine, or saliva. In addition, non-invasive investigations of lung volumes, heart rates and pressures and a variety of neurological phenomena may be demonstrated on, with, and by high school students. Both of these lab approaches offer the instructor and his or her students the advantage of studying the human organism from a holistic as well as a reductionistic point of view. Individual body functions and structures are typically investigated on a systems basis, a methodological formatsustained by most available texts. Other, more diverse aspects of human biology, such as homeostasis, control mechanisms and defense are integrated through a variety of units in endocrinology, immunology and neurology. A variety of diverse lab activities offer opportunities for independent research, a strong preparation for collegiate challenges and career insight.

PURPOSE

The purpose of this project is to develop an alternate series of experiences for students in a secondary Human Anatomy and Physiology course. These labs are intended to complement traditional dissections and physiological analyses. These exercises may be adopted at a relatively low cost. They utilize microscopes currently found in a typical biology classroom. These activities do not require extensive training and the development of new skills by the participating students. Furthermore, these labs will serve as a cohesive focal point within the established course of study. These labs offer a visually unique and important perspective to students seeking to understand both human structure and function.

The lab experiences developed as part of this project center on the branch of biological sciences termed "histology." The scientific concept of *histos* (Gr: "woven tissue") had its origins in the microscopic studies of the 17th century. Hooke, Swammerdam, and van Leeuwenhoek are generally credited with the initial discoveries of those varied and microscopic structures,i.e. cells, which constitute the basis of framework and function of all organisms. The invention of the advanced, compound microscope in 1830 allowed further discoveries, by increasingly sophisticated means, of the varied complexities of plant and animal cells. The years 1852 through 1882 are referred to by cell biologists as the "Golden Age" of research. During that time period, animal cells were first classified in four essential categories. The basis for classification are the physical features of the cells, their embryological origins, and their functional capabilities. Cells that share a common shape, size, and coloration, upon treatment with chemical dyes, are held to be biologically related. Such similar cells are collectively termed "tissues." Four basic animal tissue categories were established in the 19th century. All human cells are regarded today as being in one of these categories. Human cells are classified as epithelium, neural, muscular, or connective tissues. Within each broad category exist numerous subgroups which are themselves functionally distinct and visually discernable. Each organ of the body, in turn, is composed of unique arrangements of these tissues. In addition, an organ or body structure that is damaged or diseased displays a unique pattern of aberrant, microscopic features. Abnormally sized, shaped, or colored cells are capable of being identified by students. Most human disorders commonly introduced in an anatomy and physiology class may be investigated from this histological perspective. The presentation and exploration of pathological samples offers an analytical challenge to the student in addition to viewing normal tissues.

ASSUMPTIONS

Several assumptions undergird the development of the student labs. The most central of these is the premise that labs are an important and distinctive feature of scientific studies, especially in the development and comprehension of scientific concepts. A review of the pertinent literature will examine this premise. It is generally held that lab activities, as opposed solely to lecture or lecture-demonstration models of instruction, are a significant and valued method of learning in the science classroom (Yager, 1983).

As a specific area of scientific inquiry, histology has been critically referred to as a discipline that is at once visual, precise, scientifically rigorous and esthetically satisfying (Worthington, 1983). By offering this cellular connection between the body's structures and functions, the student is engaged in re-orienting his or her views on human health and disease processes. Histological samples, commercially prepared , can be examined, analyzed, and appreciated on an individual and class basis. The science of histology serves as a unifying focus of study, uniting a wide variety of biological and health disciplines. Embryology, biochemistry, immunology and parasitology are but a few of the topics that can be investigated via the microscope.

Bacon (1983) states that histology is the ultimate "what you see is what you get" science (p. 2). He asserts that histology is a matter of visual discipline. Critical and informed observational skills, the hallmark of scientific enterprise, can achieve a renewed importance in the histology lab as students work independently to inspect and analyze a variety of pre-selected tissue samples. Bacon cautions that

> ... a student of histology must not simply look; one must inspect within a system and with an objective. The essence of scientific study is to observe and recognize differences and similarities. By determining and identifying form, dimension, and critical characteristics, one can develop a useful morphology constructed of cells, tissues, organs or systems (of the body). (p. 6)

The students' capability to recognize, analyze, and appreciate tissue samples is predicated upon their abilities to utilize the classroom microscopes. This project relies on the fact that students enrolled in this anatomy/physiology course have successfully completed an introductory biology course which required significant competence in such manipulative skills. Sufficient retention of these skills should remain as students undertake the histology labs. During the initial lab periods allowed for these investigations both sufficient time and opportunities exist for the instructor to evaluate students' capabilities. If inadequacies are assessed, additional instructional time will be incorporated for skill remediation. Students are expected to have a basic knowledge of cell theory. If need be, introductory concepts can be reviewed in the lab preparatory presentation. Students' actual previous experience with histological samples is limited. Within the current framework of the first year biology course of studies, students are allotted one lab period on animal cells and four labs on botanical specimens.

A second technical assumption regards students' ability to represent their observations in the form of detailed, line drawings. Their previous experiences in Biology 1 included a strong emphasis on representational skills in the form of lab drawings, lab reports and graphic displays. Instruction and encouragement on the practical aspects of rendering concise analytical drawings will be offered both at the initiation of the course and throughout the year.

A final assumption with regard to student efforts is of a more practical nature. The novel opportunity to study human tissues is certain to spark the interest of the students. Most have enrolled in the anatomy/physiology course in the culmination of their four-year science program. These students have been found to be strongly motivated towards careers in the fields of science and medicine.

With these assumptions in mind, a student manual of histological investigations has been written. This manual consists of eighteen activities which are presented to the student in the form of individual lab reports, These activities complement the sequence of anatomy and physiology units already established.

MANUAL ORGANIZATION

A typical histology lab will require a student to inspect, sketch, label, and analyze one half-dozen slides. For some labs, all students will be presented with the same specimens. As students become more familiar with the visual challenges afforded by the specimens and more confident of their abilities, independent choices of slides may be made. For example, the oncology lab offers each student the choice of any six slides from a catalog of eighteen various cancerous tissues. The total class inventory of all the different specimen samples is currently near one hundred and sixty. Of these, ninety-five have been selected for the first edition of this lab manual. Additional appropriate slides will be purchased as they become available through biological supply companies and as new topics of study are introduced within the course. The most recent purchase involves pathological specimens of lung and skin which highlight the selective damage due to AIDS. As designed, all current anatomy / physiology units have a corresponding histology lab report. Evaluation of the report will be integrated with the more traditional dissection grades, literature reviews, quizzes and unit tests in the determination of the overall grade.

LIMITATIONS

There are several limitations to the implementation of this project. As noted above, pre-existing experience and knowledge of basic lab skills is a desired quality of incoming students. These labs are not intended for inclusion in a standard, first year biology course. Nor is this manual designed for inclusion within an Advanced Placement biology course. The latter, designed as an enriched and accelerated version of an introductory course, generally does not include such an in-depth analysis of concepts limited to human biology.

A number of the limitations placed on the successful implementation of this manual are of a temporal and physical nature. The ideal science classroom would independently furnish each student a microscope. A classroom set of histology slides would allow all students to work on the same specimen at the same time in a cooperative fashion. Such a set of slides, and the multiple views they afford of, say, a pancreas or brain tumor will also present a significant lesson to the class. The varied views reached at different lab stations should encourage students to realize that there exists no singular "right" perspective which is to be slavishly sketched. Any number of unique perspectives may effectively demonstrate the acquisition and comprehension of histological concepts. The twin ideals of sufficient microscopes and slides might well exceed the fiscal capabilities of the school's science department. Commercially prepared slides retail in a price range of $1.85 to $5.45 per slide. Microscopes may well be the single most expensive piece of lab equipment in a science lab. Prices range well upwards of several hundreds of dollars. To secure adequate materials for a histology lab such as is proposed would demand an on-going budgetary commitment over a period of years.

A second limitation to the institution of these labs is the adequacy of student lab time. A typical histology lab is designed to allow the student to review six slides in ninety minutes to two hours of class time. Additional time should be scheduled as students acquire research passes out of study halls, lunch rooms and at other, mutually convenient times. Students in this particular course have been annually challenged to make use of such opportunities.

Histology labs pose additional demands on the instructor's time and efforts. A strong teacher background in histology is required. Any slide specimen scheduled for class work needs to be thoroughly reviewed and interpreted by the instructor. Time also plays a role in the efforts the instructor must make to maintain an adequate tissue collection. Ideally, the slides would not be the sole source of information for the students. Reference texts, medical encyclopedias, charts and 35mm slides may all be acquired, presented, and maintained, albeit at some additional expense in the development of a class resource center. Additional funding for these materials my be secured through the expeditious use of community resources. For, instance, hospital pathologists may be willing to donate items from their own medical school collections. Community and professional grants may serve as another source of extracurricular funding.

In comparison to "real" histology, it must be acknowledged that students are looking at the end product of professionally prepared and commercially obtained specimens. This writer, from personal experience of extended lab preparations, is of the belief that the prodigious time and effort required to produce slides from freshly deceased or preserved specimens would be an inefficient utilization of class time and quite difficult to pursue in a high school lab.

A year-end class activity, currently in the planning stages, will address this last limitation. Carolina Biological Supply Company now offers, in kit form, a selection of tissues and chemicals which allows for complete slide preparation within several hours. Such a kit has been ordered for field testing in the high school lab this fall. The kit's acquisition and successful field testing will afford this year's histology lab some limited experience in actually preparing lab samples. If successfully evaluated, this kit will serve as the culminating lab activity of the year, to be offered in conjunction with the gerontology unit of study.

Although initially idiosyncratic to a particular high school science program, it is possible that given the necessary funding, materials, time, and additional resources, as well as instructoral commitment, this project could be successfully adapted within other school systems.

CHAPTER II

REVIEW OF THE LITERATURE

This review offers a summary of research associated with secondary school science labs. It will initially describe the results of inquiries which have sought to define what is meant by "lab work," as well as the perceived role of such activities in the high school science curriculum. Reports critical of these initial assumptions will be cited. Additional studies will attempt to identify characteristics of effective labs and successful learning environments.

RESEARCH ON LAB ACTIVITIES

An initial review of the professional literature of the past two decades revealed a dearth of articles specifically addressing the development, implementation, or evaluation of a secondary histology program. Substantial data does exist regarding secondary science labs. Generally regarded as a key characteristic of science education, labs are similarly held to be of unique value to the educative process. Historically, a laboratory emphasis at the secondary level is a long established tradition in American education (Gallagher, 1987).

The redefinition of secondary science goals and adequacies in the early 1960's emerged as a response to the challenge of Sputnik (Hegarty, 1987). An important caution was sounded by Oliver (1967). His comparison of instructional strategies identified no significant differences in student performance among groups who had lab experience as contrasted to those in lecture sessions alone.

A comprehensive, integrated program of lab and class activities was proposed by the Biological Science Curriculum Study group (BSCS) in that same decade. There are three versions of the BSCS program, with distinctive emphases on organismal, ecological, and cellular biology. These programs have received much acclaim for the continued development of integral lab activities (Welch, 1981). The modern definition of lab work typical of BSCS and other programs is much more eclectic than labs offered a generation ago. Controlled exercises, experimental investigations, individual and small group research projects, along with audio-tutorial experiences and computer assisted instruction all come under the aegis of "lab work" (Dunn, 1986). These activities are expected to achieve several educational goals. Klopfer (1971) states that the goals of lab teaching are the acquisition of knowledge, comprehension of concepts, development of manual skills, processing and utilizing the elements of scientific inquiry as well as the development of an appreciation of methodology and discovery. Given these many and diverse expectations, numerous authors have answered the interrogatory "Is the science lab necessary?" with qualified affirmation.

Much research has been done in an effort to further define and evaluate the role of the laboratory in the secondary school science program. In a review of selected research, Shulman and Tamir (1973) analyzed a number of studies on teaching the sciences in the 1960's, with a specific emphasis on lab studies. Five categories of lab outcomes were compiled from previous research. The categories are skills, concepts, cognitive abilities, understanding the nature of science, and student attitudes. The authors noted that these objectives are strongly similar to those suggested for science teaching in general. They also describe the then current acknowledgement of the value of lab activities as being based more on anecdotal than empirical evidence (Bates, 1978).

Sorenson (1966) evaluated changes in critical thinking among high school students in separate lab-centered versus lecture-centered biology classrooms. The lecture-demonstration group showed no significant changes on measurements of critical thinking or the understanding of scientific concepts. The lab group demonstrated significant gains in both categories.

Coulter (1966) compared groups of students involved with inductive lab experiences with those individuals subjected to a more traditional lecture-demonstration presentation. No significant differences were measured between the two groups in the areas of factual knowledge or critical thinking. Students in the lab group did significantly better on an assessment of lab techniques. They also were more positive towards instruction and demonstrated a superior scientific attitude.

Bredderman (1988) offers a meta-analysis of nearly sixty studies involving 13,000 students in 1,000 schools over a fifteen year span. He states that " When results of all the reported studies are averaged, the evidence shows that children in classrooms where activity based programs were used outperform those in comparison classrooms" (p. 39). In a comparison of student performance areas, students in such activity-based science programs posted gains in science process skills, creativity, attitude, logical development, linguistic development, perceptual skills and math capabilities. The average percentile gain was twenty percentile units for students in such activity-based science classrooms.

The literature offers various insights to a number of related areas of investigation. Analysis of student and instructor lab skills, evaluation of lab programs, and interpretations of student and instructor behaviors in the lab environment have been reported.

Lunetta (1981) concludes that lab experience alone will not ensure that the student will necessarily acquire all of the goals of science teaching. Labs, nonetheless, may serve as an important means of attaining a number of teacher goals. He also recommends that lab instructors seek to incorporate laboratory goals within their system of evaluating student performance and skill acquisition. A variety of written reports, practical exams, and observations are suggested for the instructor wishing to encourage the student to learn science by doing science.

Tamir and Lunetta (1978) propose a methodology by which lab investigations may be reviewed. This analytical tool is applied to the BSCS (Yellow version) biology textbook. They focus primarily on those lab tasks expected of students and instructors utilizing this particular course of study. Specific deficiencies are cited in those lab activities that do not allow for adequate student opportunuty to develop independent investigations. Lab exercises that do not allow for post-lab discussion and evaluation are also poorly regarded. A subsequent article (Tamir and Lunetta, 1979) offers a task analysis inventory which the lab instructor may apply to any class exercise.

The behavior of students in science labs has also been evaluated. Penick (1981) devised an observational instrument for specific use within an activity -oriented classroom. His Student Laboratory Interaction Categories-Student LIC was developed in a number of secondary science labs. He also cites the psychological role that labs provide students in working on an independent basis and the advantages of discovering and getting at knowledge first hand. Penick writes: "As many educators have been recognizing for some time, really evaluating learning is more than looking at the curriculum, the teacher, or the tests--looking first at what students are doing is an absolute must" (p. 600). This checklist offers the lab instructor the means to evaluate lab processes as well as the lab product. The instrument offers immediate feedback to the instructor while class is in session, thus allowing for subsequent modification of student activities.

In a similar approach, Ivins (1983) contends that it is imperative that a science instructor recognize the different categories of lab activities and their subsequent cognitive demands on the student. Five categories of activities are described. They range from simple demonstrations to more independent and interactive lessons. The value of underscoring the diverse lab categories is that the instructor may alter or adjust his or her expectations of student outcomes.

Extensive research has also attended to the issue of teacher preparedness for those tasks demanded in the development and implementation of an effective lab experience. Pogirski and Voss (1972) summarize several studies which report on teacher activities during lab sessions. Interactional analysis data reveal definite patterns of teacher talk, praise, rejection, and acceptance in comparison to non-lab classroom activities. The authors promote the use of a self- appraisal instrument designed to assist the educator in making a more comprehensive assessment of teaching behavior. Such behaviors are further related as being influential on both the cognitive and affective development of the student.

The development of a core of biological techniques directly related to lab activities has been described (Beisenherz and Probst, 1973). In this model for teacher education, one hundred and fifty-four separate skills are selected for implementation in either pre-service or in-service courses. James and Crawley (1985) also elaborate on those skills necessary for the teacher wishing to develop a successful lab program. They state, in part, that " In the past it has apparently been assumed that teachers would gain preparation for laboratory teaching in experiences provided primarily through courses taken as part of their science major" (p. 13).

This theme of preparedness is continued in an exploration of those lab skills necessary to define instructoral competence (James and Stallings, 1977). Again, both pre-service and in-service opportunities for lab instructors are highly recommended, as are self- and program assessment tools. Their demographic study of 184 Kansas biology teachers generally demonstrates a strong background of science training in specified lab areas. A similar study of experienced lab instructors identifies specific, desirable teacher competencies in the lab environment (Voltmer and James, 1982).

Several researchers contend that the actual practice of secondary school science labs have fallen short of the intended educational goals (Blosser, 1988; Welch, 1981). A review of laboratory research by Walberg (1991) includes the assertion that "...it (lab work) is often a perfunctory exercise following a recipe...it may be satisfying but add little to conceptual mastery. When it goes awry, it may provide an excellent serendipitous example for the rare master teacher to exploit. But often it can waste time" (p. 48). Walberg's primary focus is on the science curricula of third world countries having limited funds and facilities. His economically expeditious recommendation favors the development of science classrooms with strong emphases on textbook exercises, lecture-discussion and homework methods of instruction. Such courses could be implemented and sustained at a fraction of the cost needed to furnish science lab facilities. Walberg does include strong recommendations for specific pedagogical training in undergraduate programs. His report acknowledges the research into substantial effects of specialized in-service programs for lab instructor (Walberg 1988; Gallagher, 1987). Related research by Tobin (1987) described several case studies which indicated that despite the perceived value of lab experiences, such activities were poorly implemented and often failed to afford students the opportunity for genuine inquiry. Layton (1989) speculates that a key cause of dysfunctional labs may well be instructor inadequacies in terms of teaching skills or an understanding of scientific processes.

RESEARCH ON SCHOOL LAB PROGRAMS

Several researchers have investigated instances in which labs do function. Yager's (1986) review of six school districts identified by the National Science Teacher's Association is one such study. These schools were recognized as part of the NSTA's Search for Excellence program. Yager's evaluation of commonly held school characteristics led to the conclusion that lab activities served a vital and integral role in their respective school's science programs. Distinguishing characteristics included a strong community and district commitment to the entire

K-12 science program. Inservice training for science teachers and an exceptional teaching staff were among features cited.

Individual lab strategies that have proved to be effective have been noted and evaluated by numerous investigators. Tamir (1989) has developed a lab analysis inventory which includes elements of planning and design. In addition, this instrument allows for an evaluation of the qualitative and quantitative performances by both the instructor and the students. Research into those methods teachers use to evaluate lab progress has been summarized by Kanis (1991). Of particular interest was the physical environment of the lab with regards to the positioning of lab stations and the effective grouping of students.

Rubin and Tamir (1988) have analyzed the use of advance organizers in the lab setting. They have performed a number of empirical studies on such preparatory exercises with ninth grade science students. In conclusion, they recommend that two to four periods of advance organization precede a minimum of three hours of applied investigatory lab work.

A Nigerian study (Odubunmi, 1991) offers a variation on the initial question of the value of lab work in comparisons of students in lab and non-lab settings. Of special interest is Odubunmi's conclusion that low achievement students in the experimental (lab) group perform better on standardized tests than their counterparts in the control (non-lab) group. Tobin (1987) and Kahle (1979) both assert that the key component of successful science labs is the instructor's effective and assertive management style, clearly communicated student expectations and a firm commitment to excellence.

Treegast (1991) has authored case studies of two exemplary Australian biology instructors which underscores this last assertion. His description of the importance of teaching styles and class time on task reveals that almost 35% of class activities may center on lab work of an individual or small group basis. Furthermore, the excellent teachers utilized lab experiences to foster inquiry as an integral part of the course. In a recommendation contrary to that cited above, few prelab instructions were issued.

Further investigation of the supportive, successful roles that teachers play in an optimum lab environment are reviewed in Tobin and Kahle (1990). Kahle (1979) also defines the meaningful lab experience as being inclusive of those educational elements of inquiry, involvement and quantification. Students' abilities to organize knowledge through recall, cognitive processing, classification and creativity (Sund, 1973) affords the professional instructor both insight and impetus in the institution and management of an effective lab program.

In summary, there does not seem to be a concensus regarding the efficacy of lab work. Lab activities intended to serve as a vehicle of scientific discovery will have their success predicated upon the instructor's own professional characteristics and expectations. Effective labs cannot run themselves. Substantial instructor training, time and teaching skills must combine to offer the student the most beneficial of lab experiences.

Researchers agree that further study of labs and learning needs to occur. In acknowledging the complexity of human learning, Hofstein and Lunetta(1982) reiterate how appropriate labs can be effective in promoting the development of logical thinking, inquiry, and some problem-solving skills. They note: "(Labs) can also promote positive attitudes, and provide opportunities for student success and foster the development of skills in cooperation and communication " (p. 212). They contend that there exists numerous variables yet to be studied that are important to the effective science lab experience. These include a more thorough analysis of teacher attitudes and behavior, the content and nature of laboratory activities, instructional goals, social variables in the learning environment, management of lab activities, student behavior, intellectual development of lab practitioners, concept understanding, both math and manipulative skill levels and the development of student attitudes towards a variety of relevant issues. These promising areas for research are sure to attend to many factors which influence student learning. The varied approaches recommended should highlight those products of the student lab experience beyond the limited attention to cognition alone.

As more precise information regarding these research questions is forthcoming, the science teacher will become more effective in facilitating student learning in a laboratory environment.

HISTOLOGICAL SOURCES

In the development of the histology labs for this manual, several scientific sources are to be greatfully acknowledged. Numerous sources have helped this writer arrive at a better understanding of the important role of histology in the study of human biology. These texts were selected from those available in the holdings of the Roesch Library at the University of Dayton and Wright State University's School of Medicine. These sources are specifically identified in a separate bibliography to be found at the conclusion of the student lab manual. A complete list of all locally available histological texts and atlases will be provided to students.

CHAPTER III

A STUDENT MANUAL FOR HISTOLOGICAL INVESTIGATIONS

This manual of lab activities is designed to supplement and enrich the student's investigations into human anatomy and physiology. The manual consists of a series of 18 labs offered in a sequence which parallels the current course of study. The units of the course are:

1. Introduction to Histology and the Integumentary system
2. The Skeletal system
3. The Muscle system
4. Hematology
5. The Cardiovascular system
6. The Respiratory system
7. The Gastrointestinal system
8. Nutrition and Metabolism
9. The Reproductive system
10. Embryology
11. The Renal system
12. Endocrinology

13. Immunology
14. Neurology I: Individual neurons; the spinal chord
15. Neurology II: The Brain
16. Neurology III: Sensory systems
17. Oncology
18. Gerontology

A typical lab consists of the examination of six selected histological slides. The initial lab which introduces the student to a variety of tissue types is an exception to this. A dozen specimens are presented in the first unit. They offer an introduction to the cellular variety and complexity of the human organism. These primary slides should sufficiently provide the student with the means and opportunity to comprehend the rudiments of histological science. Other exceptions to the number of slides presented occur in subsequent units on neurology and embryology. In these labs, only one or two slides of a substantially more difficult nature are presented to the student.

These professionally prepared slides are commercially available through most science supply houses. Those appearing in the student manual have been specifically selected as representative of those body structures to be reviewed in the lecture-demonstration as well as the student anatomy (i.e. dissection) lab portions of the course. Whenever possible, specimens have been selected from catalog source listings of actual human tissue. A number of specimens are of related mammalian organisms.

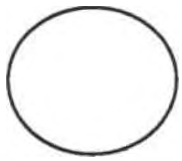
For most labs, a number of pathological specimens are offered in contrast to the normal tissue or organ under study. For example, normal lung tissue is to be compared with anthracosis ("black lung"), tuberculosis, and hyaline menbrane disease.

A typical lab will be prefaced by a lecture presentation accompanied by relevant 35mm slides of the attendent tissue samples. This methodology is intended to establish a perceptual anticipation of what is to be viewed. Prior reading assignments in the student text as well as referrals to available reference materials will also establish the set of the lesson.

On average, a lab session consisting of two forty- eight minute class periods is anticipated to be of sufficient time for the student to perform the assignment. Each student is required to correctly utilize the microscope in bringing the specimen under view. Designated sections of the slide, possessing distinctive histological features are to be sketched in the spaces provided. A sample illustration, featuring specific labeling techniques, is provided along with recommendations and requirements for the successful completion of the exercise.

Each two to three page lab report consists of several pre-drawn microscopic fields complete with tissue labels, suggested magnifications and slide inventory number. A very brief description of those cells or structures to be sketched is included with the microscope field. For example:

1. This tissue is presented as single, flat layer of cells

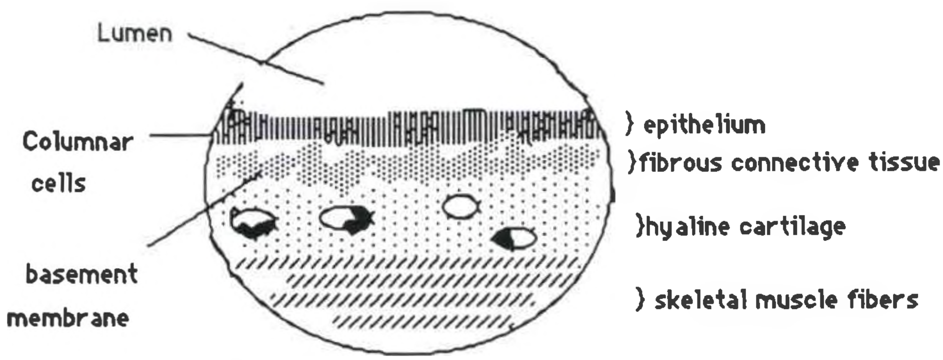


Simple squamous epithelium 400x

(#108)

A completed histological sketch, complete with labels would resemble the following:

1. Display slice of tissue showing lumen, mucosa, submucosa, cartilage and muscle.



Trachea 400x
(#110)

Cells and tissues should appear in proper proportion and relationship to one another. Additional spaces surrounding the drawings may be used to annotate the significant features of each study.

The completed lab reports will be submitted at the conclusion of each unit of study. Evaluations will be based on scientific as well as artistic accuracy. Structures must be correctly and consistently identified. These grades will be incorporated with other lab reports, test results and research projects in the overall determination of the student grade.

The implementation of this student manual will begin with the academic year 1992-1993. Arrangements will be made with the school district's print shop to transform the enclosed manual into individually bound student copies. Upon conclusion of the year of study, the returned, graded and annotated lab reports will serve as a future personal reference volume for each graduate.

A LAB MANUAL OF STUDENT HISTOLOGIES

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This student manual for Histology lab activities is designed to further develop the student's understanding of human anatomy and physiology. These investigations allow for the microscopic analysis of normal and pathological tissue samples. These labs are offered in conjunction with the more traditional physiology and anatomy exercises.

The following guidelines and examples will assist the student in the completion of these assignments.

1. Student use of a #2 lead pencil is advised.

2. Illustrations in the anatomy text and reference volumes in the class library are available to aid student interpretation of these slides.

3. A typical histology sketch should feature a representative area of tissue and include those cells, structures, spaces and layers which define the structure being studied.

4. For intact structures of a symmetrical nature, such as a cross-sectional view of a spinal column, artery or intestine, a 1/2, 1/4 ,or 1/8 representation of the specimen should suffice.

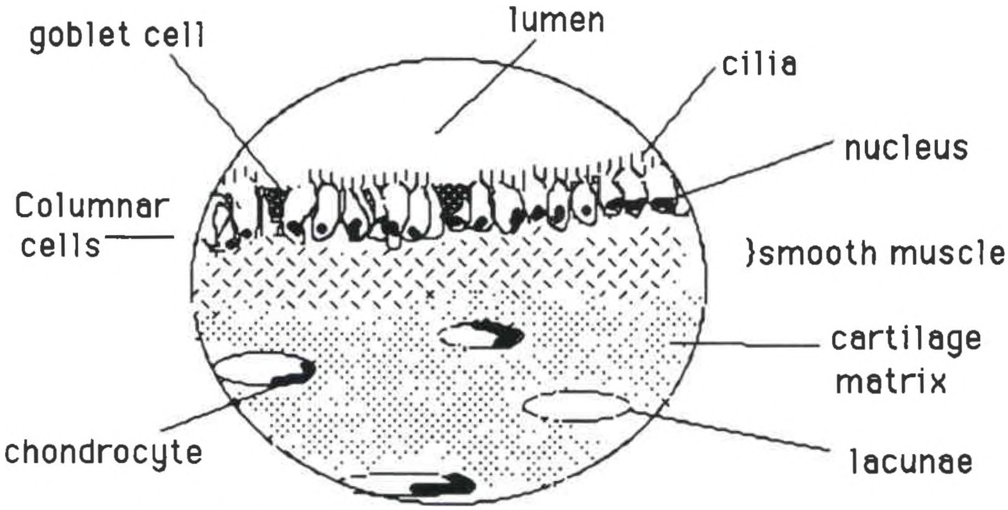
5. Recommended magnifications will be provided for most assigned slides.

6. A typical histology lab assignment will consist of six slides to be sketched and labeled by each student. A double-lab period is allocated for the completion of each lab. Additional lab times may be scheduled with the instructor as time and available facilities allow.

7. Research passes may be issued at the instructor's discretion for study halls. Lab facilities are also available At 7:30 a.m., lunch hour, and after school most school days.

8. Class reference volumes do not circulate. A bibliography of titles held at local libraries (OHS, UD, WSU, Dayton-Montgomery County, and Wright) is available in the classroom. A short, select list of texts and atlases is in-clided in this manual's bibliography.

9. The following illustration and accompanying notes are indicative of those elements of style and labeling sought in these exercises.



<u>Trachea</u> <u>c.s.</u> 400x
(#110)

<u>*Nota bene*</u> :

a) identifying arrows are straight edged and lead outside the circle of magnification;

b) labels are printed " right side up" and do not encircle the sketch; duplication of labels is not advisable;

c) regional brackets may be used to adenty distinct tissue layers;

d) identification arrows / brackets to do cross over each other;

e) specimen identification includes:

   (i) specimen name
   (ii) section (cross, wholemount, sagittal, or transverse)
   (iii) catalog box number
   (iv) magnification;

f) additional shading of tissues helps to convey information differential staining capacitiies of tissues. Colorizing or highlighting tissues is not recommended.

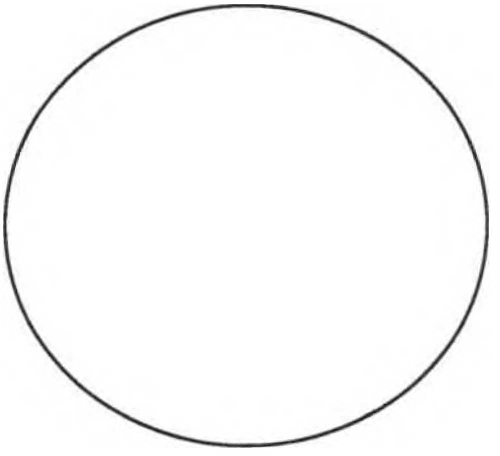
This manual is divided into the following 18 lab reports:

1. Introduction to Histology; the Integumentary system
2. The Skeletal system (Osteology)
3. The Muscle system (Myology)
4. Blood cells (Hematology)
5. The Cardiovascular system
6. The Respiratory system
7. The Gastrointestinal system
8. Nutrition and Metabolism
9. The Reproductive system
10. Embryology
11. The Renal system
12. Endocrinology
13. Immunology
14. Neurology I: Spinal Chord and Neurons
15. Neurology II: The Brain
16. Neurology III: Special Senses
17. Oncology
18. Gerontology

Each lab report will be submitted at the conclusion of the unit of study, i.e. on the date of the unit test. Throughout the academic year, it is anticipated that your expanding knowledge of human histology will be of benefit in in both broadening and deepening your understanding of human anatomy and physiology. You are enjoined to maintain a file of returned and graded labs; they will be invaluable resources to your future studies, especially in some of the latter units of this course.

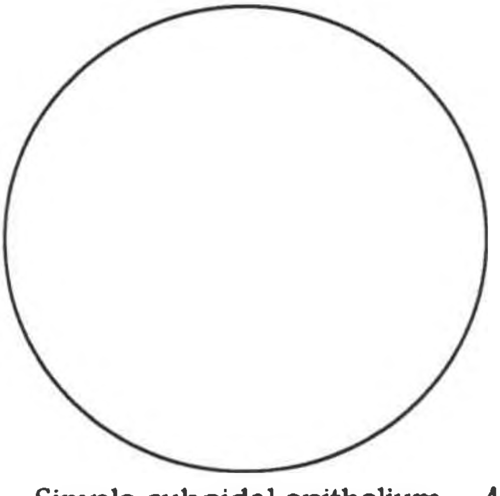
Name ____________________
Intro. Histology: Integument.

1. This tissue is presented as a single, 7um thick layer of skin cells.



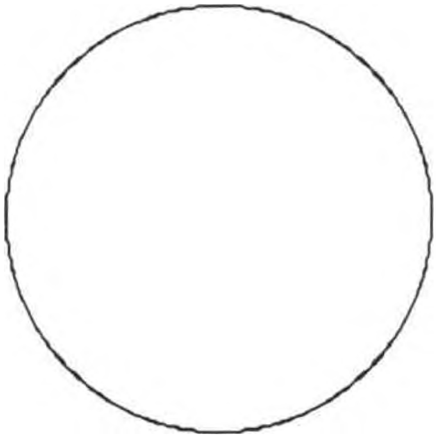
Simple squamous epithelium 400-600x
(#165)

2. These cells form the walls of numerous oblong "tunnels" within the inner layers of the kidney



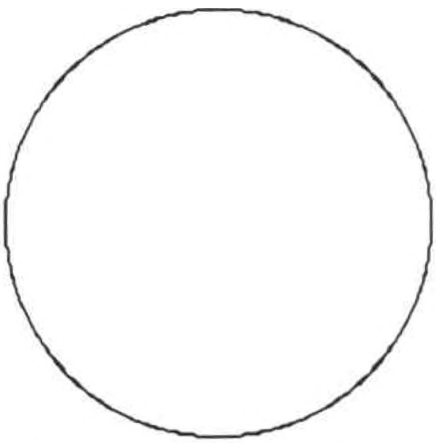
Simple cuboidal epithelium 400x
(#123)

3. These rectangular cells form the upper boundary layer of the trachea c.s.



Pseudostratified Col. cil. epi. 200-400x
(#126)

4. These rectangular cells are interspersed with stained goblet cells(blue) along the inner, folded linings of the small intestine c.s.



Stratified col. cil. epi; goblet cells 400x
(#129)

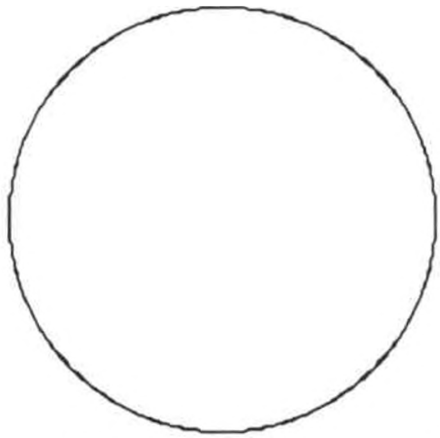
5. These cells are located in the light purple, acellular matrix centered in the trachea c.s.

Hyaline cartilage (#107) 600x

6. Cells form a dense purple/pink honey comb matrix centered between pink bands of muscle tissue.

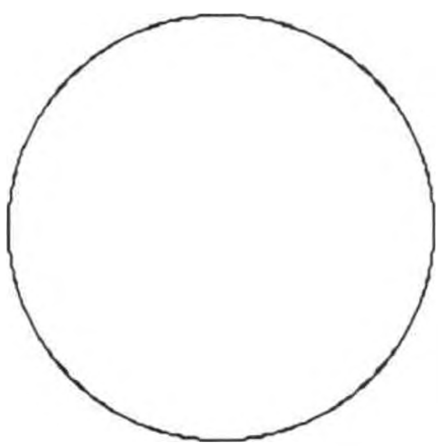
Elastic cartilage (#108) 400x

7. "Window pane" cells having large cytoplasmic reservoirs.



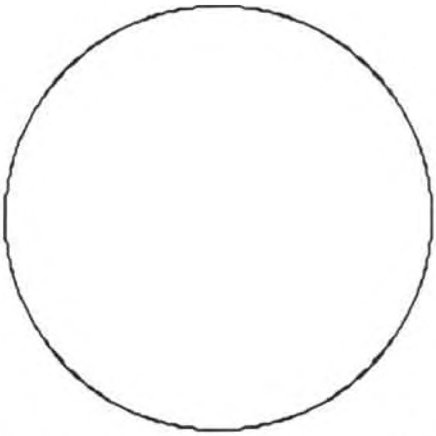
Adipose tissue (#129) 400x

8. Individual red, oblong cells in a blue fibrous matrix.



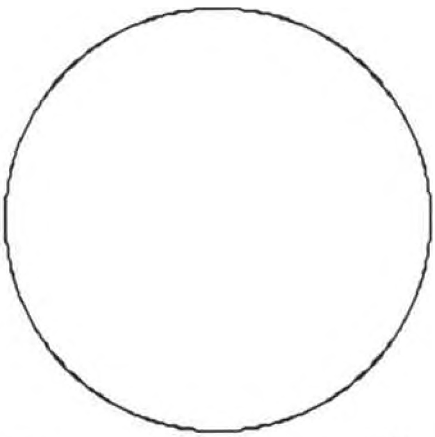
Fibrocartilage (#163) 400x

9. Individual red cells in a reddish-brown, fibrous matrix.



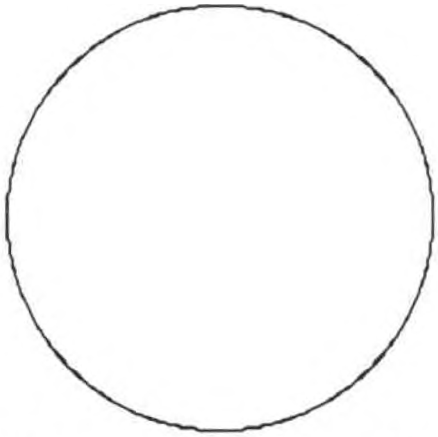
White fibrous tissue 400x
(#130)

10. Individual dermal cells mixed with melanocytes.



Skin 200x
(#192)

11. A cross section of skin displaying glandular tissues and hair follicles.



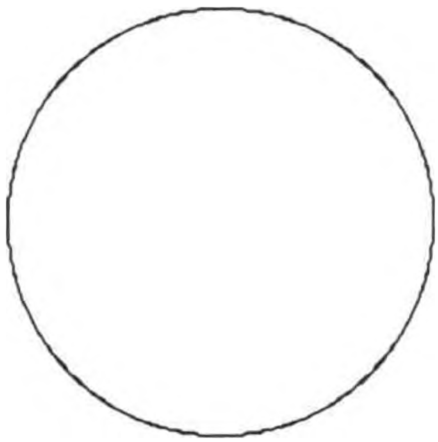
Scalp **200x**
(#194)

12. Select any one of the following pathologies to complete this lab report:

Verruca plantaris (#180)

Skin with gangrene (#194)

Skin with 3rd degree burn (#242)



____________________ _______x

Name ______________________
Osteology Histologies

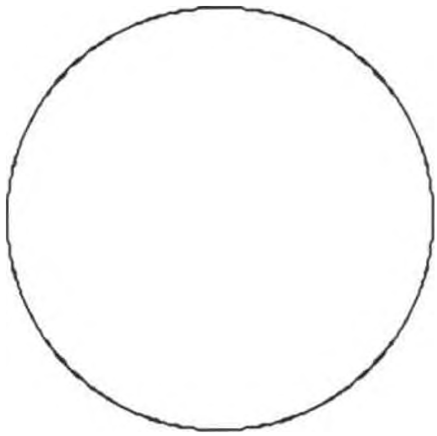
1. Sketch and label two to three Haversian system.

Ground bone (#29) 400x

2. Sketch several representative clusters of cells from the medullary cavity.

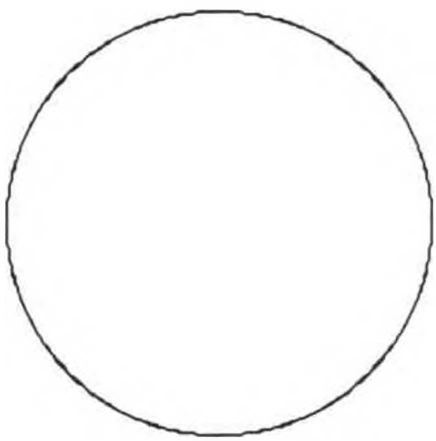
Bone marrow (#183) 600x

3. Indicate the developing osteocytes in the fibrous cartilage matrix.

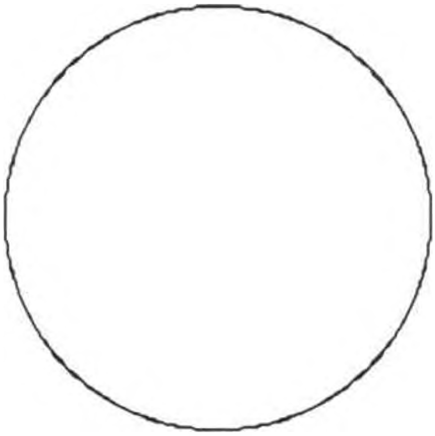


Developing membrane bone 200x
(#101)

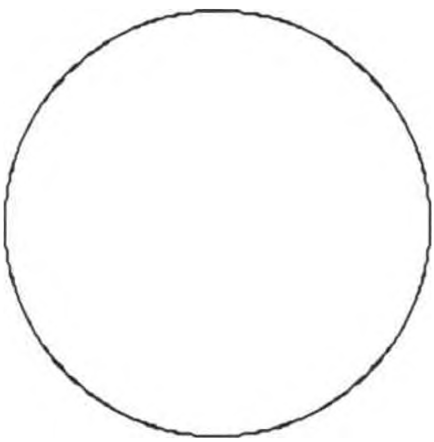
4. - 6. Prepare three sequential illustrations which demonstrate histological growth patterns through this section of long bone.



"Infiltrated marrow" 100x
(#162)



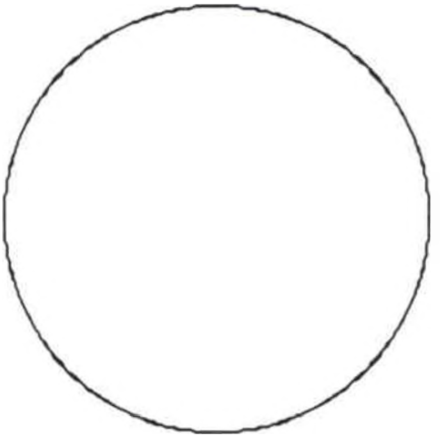
"Transitional cartilage" 100x
(#162)



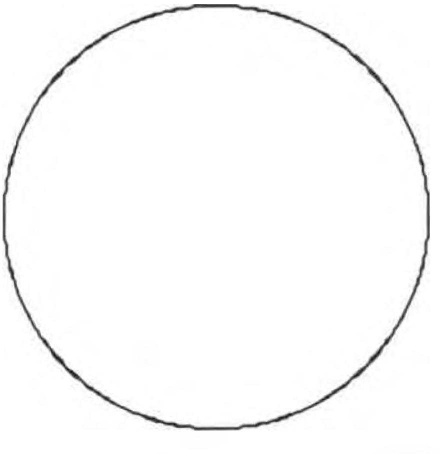
"Young Haversian system" 100x
(#162)

Name ______________________________
Myology Histologies

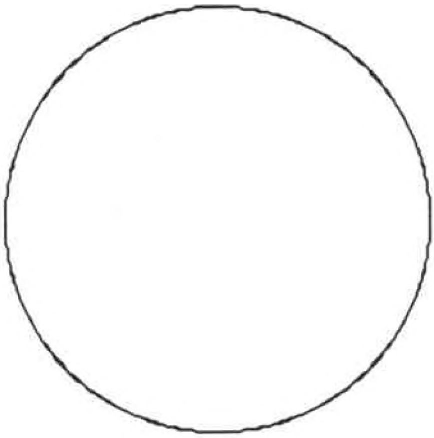
1.-3. For each of the following specimens, sketch a small arc of the middle, pink layer of cells and fibers. Include both cross sectional and transverse samples of tissue in your diagrams.



Smooth muscle (#119) 400x



Skeletal muscle (#104) 400x



Cardiac muscle (#34) 400x

Name ____________________

Hematology Histologies

1. Sketch an array of amphibian RBC's, WBC's and platelets.

Frog blood smear (#16) 400x

2. Sketch a composite field of RBC's, WBC's, and platelets.

Human blood smear (#185) 600x

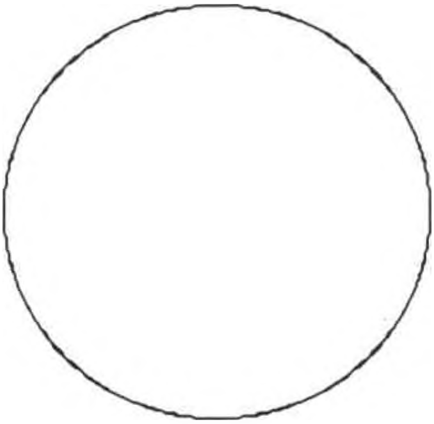
3. Diagram a cross-section of the spleen, including the capsule, red, and white pulp.

<u>Human spleen</u> <u>200x</u>
<u>(#206)</u>

4. Display a selection of abnormal red cells contrasted to normal erythrocytes.

<u>Sickle cell anemia</u> <u>200x</u>
<u>(#20)</u>

5. Sketch a selection of abnormal cells contrasted to normal erythrocytes.



Erythroblastosis foetalis (#171) 200x

6. Using either of the following pathological slides, systematically count and identify 50 leukocytes. Report your findings in the table below.

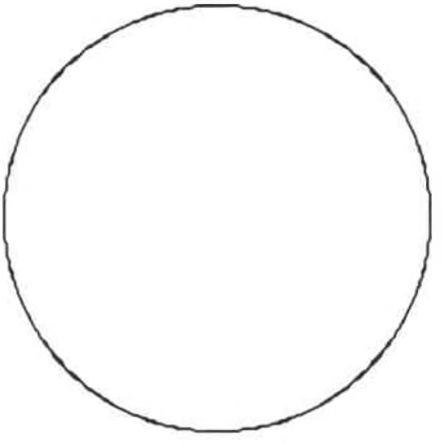
Infectious mononucleosis (#175)

Chronic granulocytic leukemia (#174)

Leukocyte	#	#
Basophylls		
Neutrophylls		
Lymphocytes		
Monocytes		
Eosinophylls		

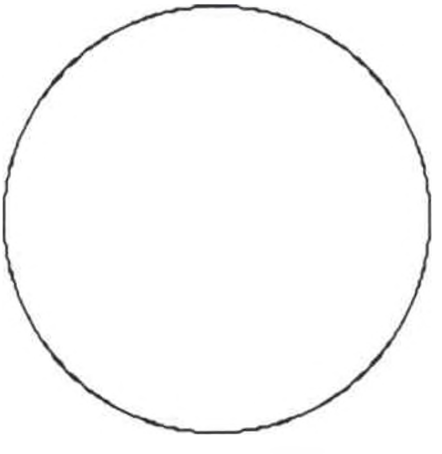
Name ________________________
Cardiovascular system Histologies

1. Sketch a cross section of the vein displayed on your slide.



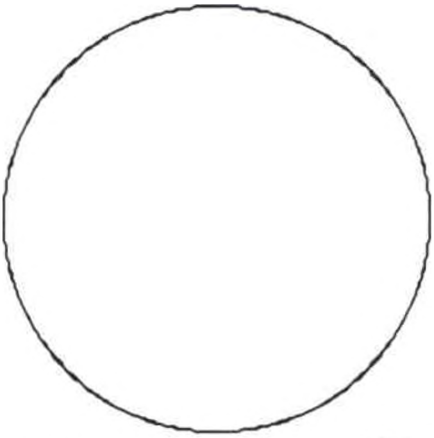
Vein 200x
(#115)

2. Sketch and label a small (1 / 4th) arc of this blood vessel.



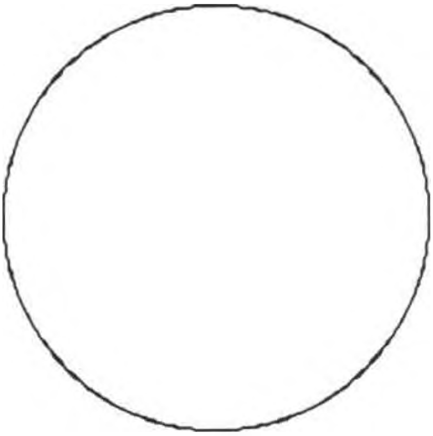
Small artery 200x
(#117)

3. The c.s. "rectangle" is a small arc of an entire vessel. Identify the lumen side.



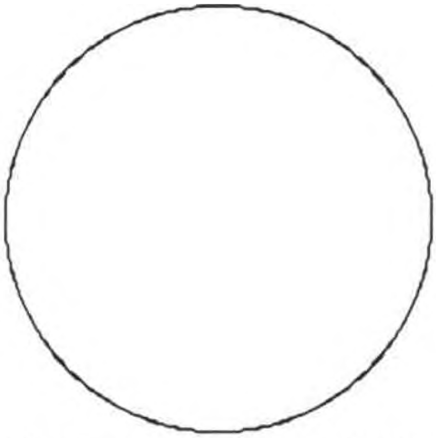
Aorta 100x
(#118)

4. Select a small cross section of this vessel and include all the layers of the wall.



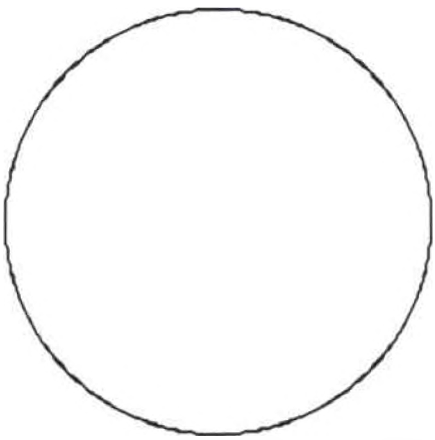
Varicose vein 80x
(#173)

5. Sketch a one-quarter arc of the vessel inclusive of a sclerotic "patch".



Atherosclerotic coronary artery 100x
(#178)

6. Juxtapose a section of necrotic cells against healthy myocardium.



Myocardial infarction 200x
(#179)

Name ____________________

Respiratory system Histologies

1. Display a slice of tissue showing the lumen, mucosa, submucosa, cartilage and muscle.

Trachea (#110) 400x

2. Display a section of normal alveoli and associated ducts.

Lung (#111) 400x

3. Sketch a section of damaged alveoli.

Pulmonary emphysema (#199) 400x

4. Sketch a representative assortment of infected, diseased alveoli.

Tuberculosis (#191) 400x

5. Display the thickened, abnormal respiratory membrane.

<u>Hyaline membrane disease (#176)</u> <u>400x</u>

6. Sketch a small section of tissue affected by "black lung".

<u>Anthracosis (#172)</u> <u>400-600x</u>

Name ____________________

Digestive system Histologies

1. Sketch a cross section inclusive of mucosal through muscularis layers.

Esophagus (#166) 200x

2. Detail the middle of the three tissue sections presented on this slide.

Stomach (#167) 200x

3. Prepare a sketch of the central (jejunum) of three sections displayed on this slide.

Small intestine 200x
(#168)

4. Include all tissue layers, lumen through serosa, in this c.s.

Colon 200x
(#169)

5. Emphasize the folded, glandular inner lining of this organ.

Gall bladder 200x
(#207)

6. Sketch a section displaying two to three glands.

Salivary glands 200x
(#249)

7.-8. Select and sketch any two of the following pathologies.

Diverticulosis (#204)
Hemorrhoidal tissue (#205)
Chronic peptic ulcer (#200)
Gangrenous appendix (#245)

Name ____________________
Nutrition / Metabolism Histologies

1. Sketch 2-3 pentagonally shaped biliary systems.

Liver (#154) 100-200x

2. Sketch a single abnormal, pathological biliary system.

Liver (cirrhosis) (#174) 100-200x

3. On the reverse side of this lab report, summarize the histological differences which differentiate these specimens.

Name ____________________

Reproductive system Histologies

1. Select and sketch a single, mature Graffian follicle.

Ovary (#211) 200x

2. Draw a cross section of the oviduct distal to the fimbrii.

Oviduct (#211) 400x

3. Display a cross section emphasizing any 1 tubule and adjacent, supporting tissues.

Testis
(#213)

400x

4. Draw a cross section of any 1 tubule, emphasizing those structural features which distinguish this specimen from the previous one.

Epididymis
(#213)

400x

5. Include in your representation several collections of glands embedded in adipose and fibrous connective tissue.

Mammary gland (#118) 200x

6. Choose any one slide of the six available in this box. Note the specific date of the stage drawn. Be sure to include both endo- and myometrium.

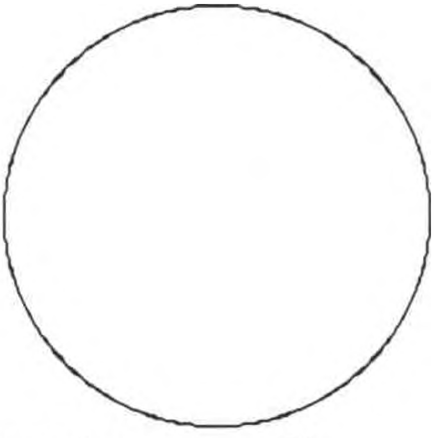
Uterine series (Day __ to __) (#49) 200x

Name ___________________
Embryology Histologies

1. In the space below, present the entire l.s. of the specimen as it appears on your slide. Given the large size of the specimen, a guide circle is not provided. Label your specific slide for later identification.

Newborn mouse, longitudinal section, entire 40-100x
(#214)

2. Sketch the entire cross section of the structure displayed on your slide.



Umbilicus (#189)

200x

Name ____________________
Renal system Histologies

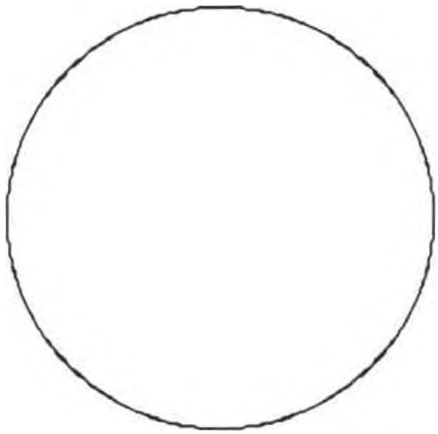
1. Sketch 2-3 glomeruli from the outer medulary section of the kidney.

Kidney (#217) 400-600x

2. Sketch any 4-6 tangential tunnels or tubules from the kidney's cortical region.

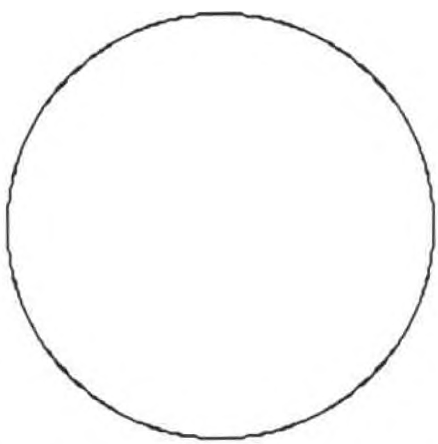
Kidney (#217) 400-600x

3. Sketch a small arc of the cross section of this structure.



<u>Ureter</u> <u>100x</u>
<u>(#204)</u>

4. Display a small section of the structure. Be sure to emphasize those features which characterize this from the previous sketch.



<u>Urethra</u> <u>100x</u>
<u>(#208)</u>

5. Portray the thinner, less dense of the two sections mounted on this slide.

<u>Bladder</u> <u>100-200x</u>
<u>(#210)</u>

6. Prepare a sketch of a composite field, displaying formed cells, casts and crystals.

<u>Urine sediments</u> <u>400-600x</u>
<u>(#210)</u>

Name ____________________
Endocrinology Histologies

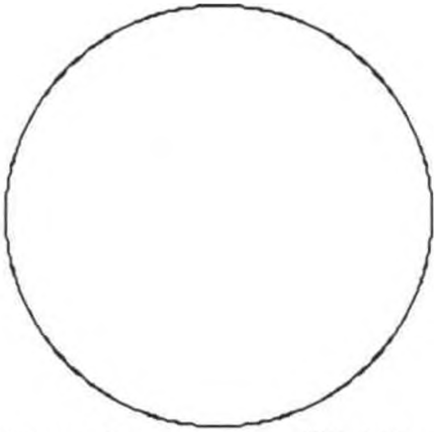
1. Sketch several follicles in cross section, including both follicular and para-follicular cells.

Thyroid (#128) — 400x

2. Portray the three distinctive zones of the renal capsule.

Adrenal (#186) — 200-400x

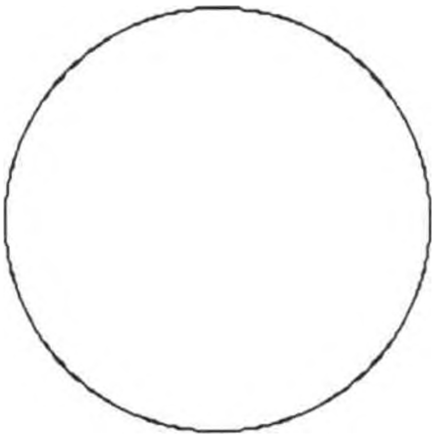
3. Include in this sketch of the medulla the sinusoidal capillaries and nerve cells.



<u>Adrenal</u>
<u>(#186)</u>

<u>200-400x</u>

4. Limit this study to the anterior, glandular tissue of the organ.



<u>Pituitary</u>
<u>(#187)</u>

<u>200-400x</u>

5. Isolate and sketch a normal islet and a sample of surrounding exocrine cells.

Pancreas (#143) 600x

6. Isolate and sketch an area of diseased tissue, inclusive of a damaged islet.

Diabetes mellitis (#195) 600x

Name ________________

Immunology Histologies

1. Sketch a cross of this organ, displaying both the red and white pulp.

Spleen
(#206)

40-80x

2. Sketch one superficial lobule, showing the medulla, cortex, capsule, and trabeculae.

Thymus
(#231)

40-80x

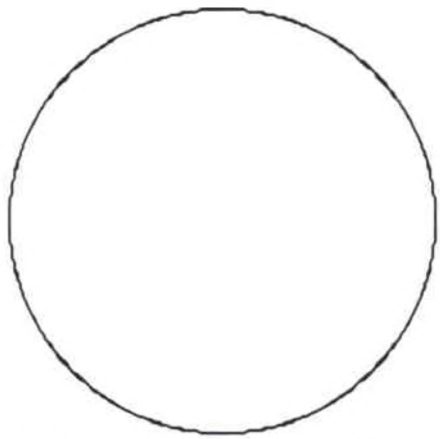
3. Sketch the capsule, cortex and germinal center.

Lymph node (#193) 80-100x

4. Emphasize the pathological differences to #1.

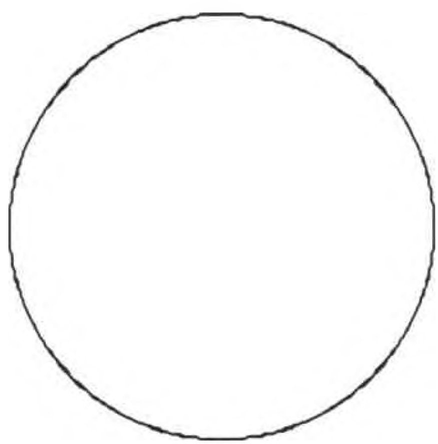
Hodgekin's disease (spleen) (#231) 80x

5. Provide a comparative study to #3, emphasizing the pathological differences.



Hodgekin's granuloma (lymph node) 80x
(#190)

6. Although not a distinct pathology of the immune system, *per se*, this specimen is included because of it's clinical importance in the diagnosis of AIDS.



Kaposi's sarcoma 100-200x
(#235)

Name ____________________
Neurology I Histologies

1. Draw two to three nerve cells, as inclusive as possible of axons and dendrites.

Neurons 400x
(#157)

2. In the space below, draw an entire cross section of the spinal chord, inclusive of any attached ganglia.

Spinal chord (cat) 100x
(#37)

Name(s) _______________
Neurology II Histologies

1. Compare and contrast the following two specimens in the space provided on this page:

   Brain, entire (rat) saggittal section adult (#156)

   Brain, " " " newborn (#246)

   This analysis may include both written commentary and labeled sketches. This Lab may be performed in cooperation with your lab partner.

Name __________________

Neurology III Histologies

1. Include all three layers of cells forming this structure. Orient the inner-most layer towards the top of the sketch.

Retina (#240) 200-400x

2. Portray any one combined vestibular-cochlear-tympanic duct within the osseous canal.

Cochlea (#240) 100-200x

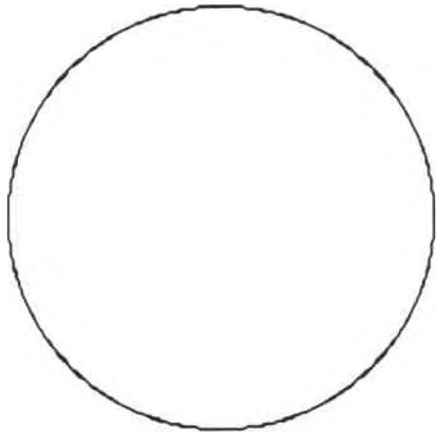
Name ____________________
Oncology Histologies

1.- 4. This lab report will consist of your choice of four of the following specimens.

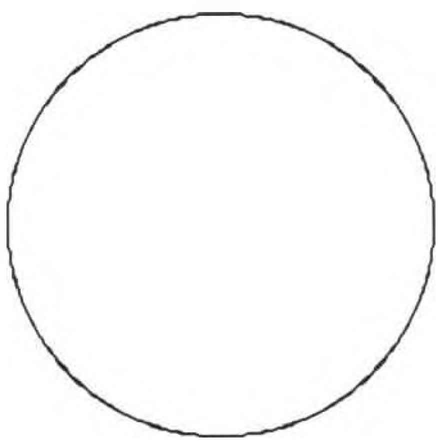
Lung, metastatic adenocarcinoma (#177)
Bladder cancer (#196)
Pap smear (#197)
Breast, adenocarcinoma (#198)
Liver, primary carcinoma (#201)
Colon, adenocarcinoma (#203)
Pancreas, adenocarcinoma (#209)
Prostate, carcinoma (#209)
Esophagus, carcinoma (#212)
Larynx, carcinoma (#212)
Bone, osteogenic sarcoma (#215)
Teratoma (#223)
Oat cell (lung) carcinoma (#223)

________________ ____x

________________ ____x



_______________ ____x



_______________ ____x

Name ______________
Gerontology Histologies

This final area of study will offer a departure from the previous units' histology lab format. Tissues indicative of the aging process are not currently available from biological supply companies. Rather, this lab will utilize a new product from Carolina Biologicals. A Readi-Stain kit will afford you the opportunity to prepare your own slides of specific tissues. Tissue specimens, dyes and instructions will be distributed from the kits. Our class goal is to field test and evaluate these materials. It will also be noteworthy to make a comparison between the quality of this product and those slides that have been used throughout the year. Your final lab report will be your commentary on these matters, written on this page and submitted at the conclusion of the unit.

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CHAPTER IV

SUMMARY & RECOMMENDATION

This project began with the intent of creating a program of histological laboratory investigations pertinent to inclusion in a secondary science course of study. A review of the educational literature has affirmed an investigative premise of the relevance and value of activity-based lab activities within the science curriculum. Further review of the scientific literature allowed for the detailed development of those primary histological concepts and principles considered relevant for inclusion within such an entry level program of biological study. The availability and expense of appropriate student materials and adequate lab facilities were considered in the development of these labs.

The outcome of this project has been the successful completion of a student lab manual for histological investigation. This manual consists of a series of eighteen inquiry and activity based exercises in which nearly one hundred specimen slides are to be reviewed, sketched, interpreted and analysed by the student. Both normal and pathological aspects of human growth, development and disease processes are introduced to the student via these studies. These histologically based studies of human health and disorder are arranged sequentially in the curriculum to serve as an enrichment to the standard anatomy and physiology labs currently in place. This lab manual will be utilized by students as part of the human anatomy and physiology curriculum at Oakwood High School beginning with the 1992-93 academic year.

An ongoing analysis of students' progress in the cognitive and affective acquisition of new histological principles and concepts will be made. The continued development of this histology program and the anticipated, subsequent revised editions of this manual will proceed, in part, from student commentary and the adjudged effectiveness of these lessons in furthering students' understanding of human biology.

FUTURE RESEARCH

There exists several further avenues of research regarding this project in addition to a comprehensive evaluation of utility and efficacy. These exercises have been specifically organized with a specific student population in mind. Professional knowledge of student preparedness and available lab facilities has produced a manual that may well be idiosyncratic to specific and limited student population.

It would be of considerable interest to determine if these labs could be utilized in their entirety, or in part, in a different classroom setting or an alternative school district having a more varied student population. Preliminary investigation of such matters may proceed via initial contacts with biology instructors in other local districts. Furthermore, if such investigation were to proceed, it would be beneficial for all classroom instructors involved to review those methods of instruction and student evaluation which best promote the processes of having students do histology in the secondary classroom.

Another area of future research suggests itself from the utilization of the computer generated graphics found in the lab manual. Student recognition of basic tissue types drawn with the current programs, MacPaint and SuperPaint, could be evaluated prior to, during, and after classroom experience with the actual tissue specimens. Such graphics, generated as part of an evaluation instrument, would be of value in the determination of student progress. In a separate endeavor, students could be encouraged to demonstrate their own graphics capabilities with the availability of the classroom computer. Examples of such graphics are included in the appendix of this report.

A final area of study would involve student evaluation of the lab manual, required procedures, and methods of evaluation. Beyond the revision process of the manual itself lies the desirability of these exercises to significantly influence both the cognitive and affective growth of these students. To the degree that student affirmation of these goals is exhibited, such a final analysis will subsequently allow for a personal and professional judgement to be discerned.

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APPENDIX

The following pages of illustrations are examples of the computer-generated graphic capabilities available through the use of the MacPaint and SuperPaint programs. These diagrams were "drawn" on a Macintosh Classic. They, and subsequent drawings -- of instructor and student origins -- will be utilized in the classroom as learning aids. They may be xerographically reproduced for individual student note-taking; alternatively , they may be transformed into an overhead projection film or selectively reproduced for a test item. The anticipated development of a personalized set of illustrations unique to those specimens being studied is not expected to forego the need nor the desirablity of having students participate in the actual lab work.

Pages 86 and 87 offer two examples of introductory exercises to students embarking on a histological course of study. They visually challenge the observer to think in 3-D, an admittedly difficult process when one's microscopically enhanced visual field is essentially two dimensional. The samples draw upon the exprience of common objects, a piece of fruit and a curved pipe, to demonstrate the apparent distortion that can occur dependent upon the angle of view. Both illustrations are adapted from Leeson, Leeson, & Paparo (1985).

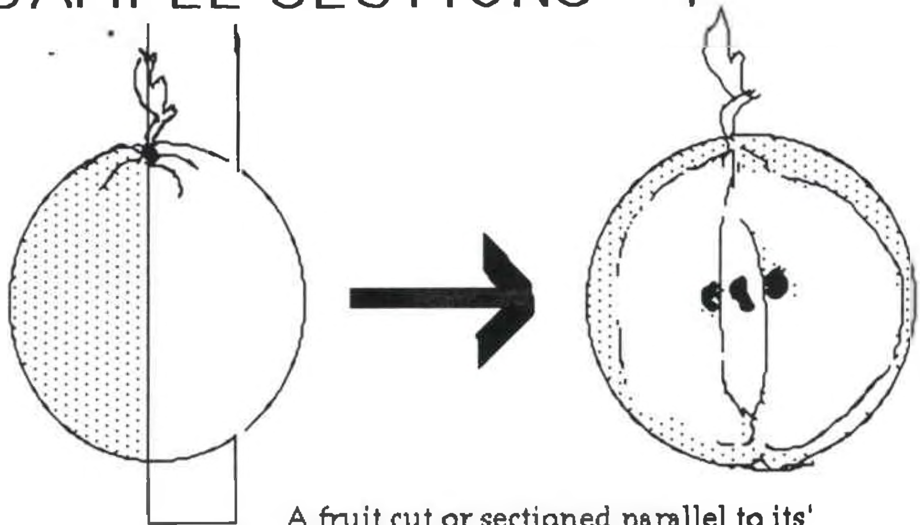
The illustration on page 88 is the original schematic for an introductory lab activity which also attempts to stimulate the visual, analytical capabilities of the student through the cooperative, physical manipulation and challenge of of items no more intricate than variously colored lumps of Play-Doh.

Page 89 is suggestive of the artistic use of these graphics in analysing students' visual recognition of specific structures.

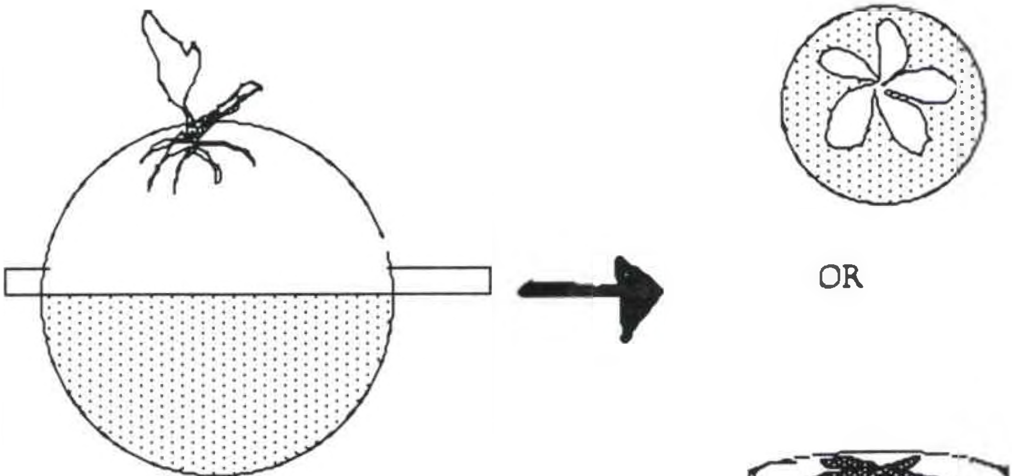
Page 90 presents an array of various cells and tissues found in the human body. It is hoped that such illustrations will prove to be visually distinguishable by students upon completion of their studies.

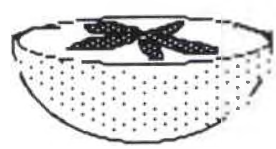
Finally, page 91 displays an enlarged view of individual cells, relating the final appearrance of the microscopically enlarged cells to their original dimensions and the depth and position of cut.

SAMPLE SECTIONS # 1



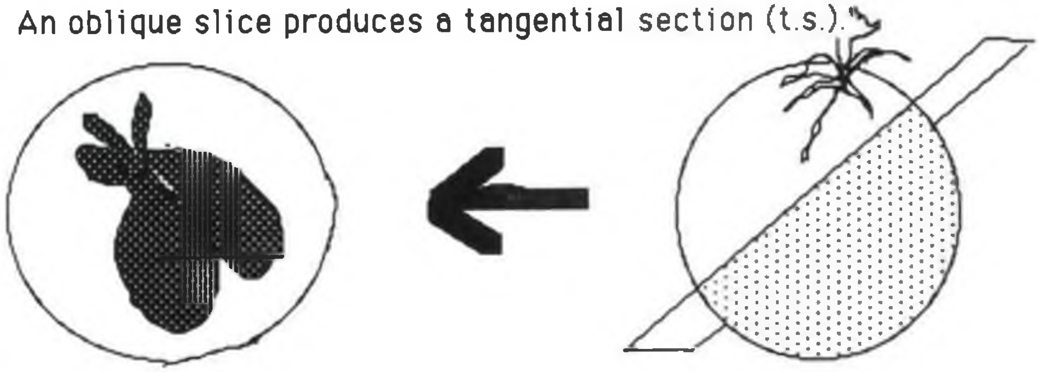
A fruit cut or sectioned parallel to its' long axis produces a longitudinal section (abbreviated as l.s.).



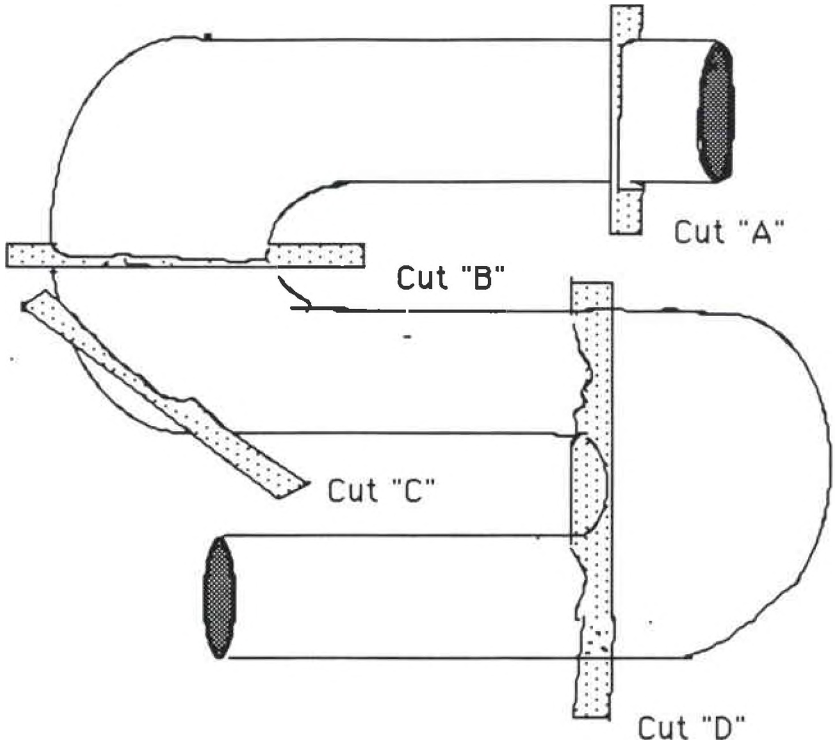


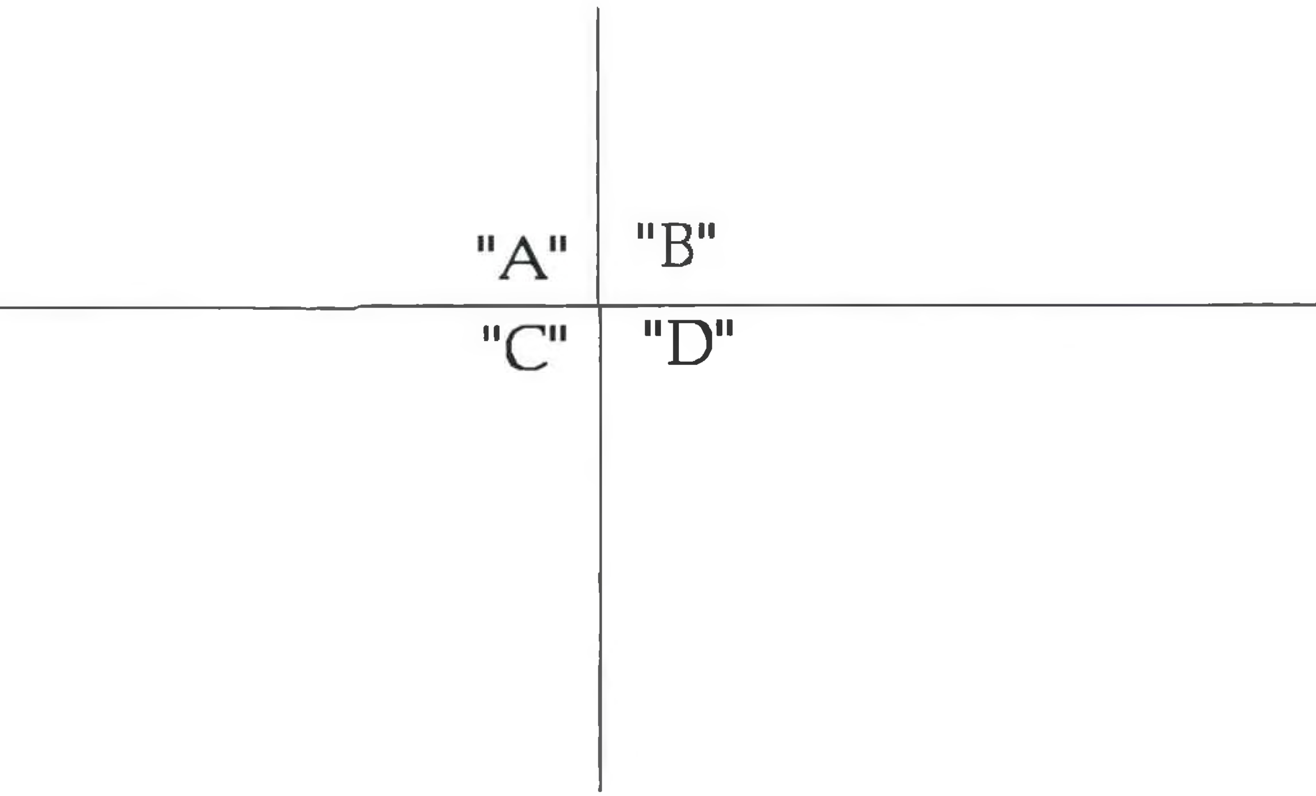
A fruit cut perpendicular to the long axis will produce a cross-section (c.s.).

An oblique slice produces a tangential section (t.s.).



Sample Sections #2





Sample Sections #3

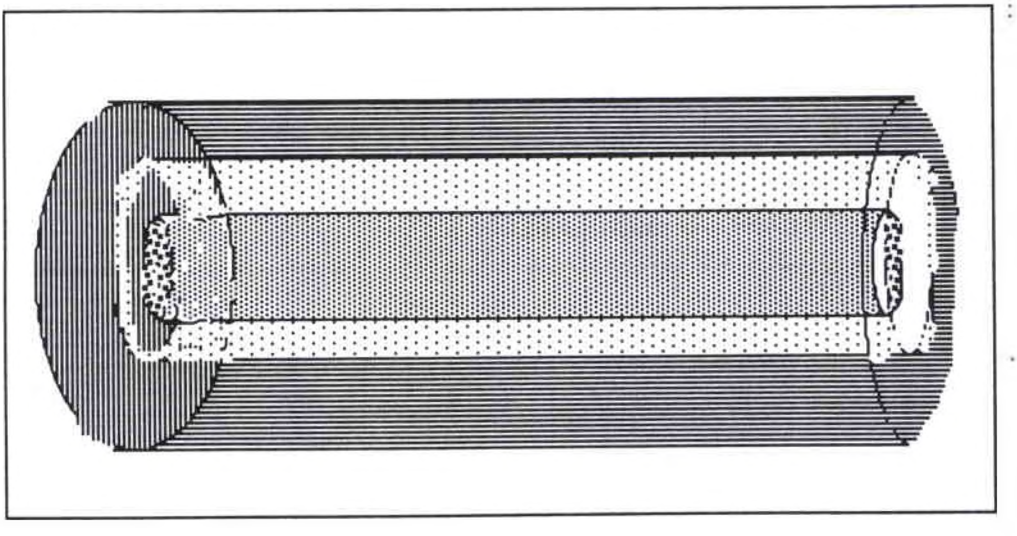
1. Construct the following object using the materials supplied by your instructor. Your lab team is to work independently of other teams.

2. Write ,or sketch a prediction of how your team's object will appear when displayed in whole, cross, longitudinal and oblique sections.

3. The illustrations below may help you to visualize this task but you are not limited to this design .

4. Upon completion of your construction, slice it along any one plane, producing a thin section. Trade these sections with an- team and attempt to recreate the original shape/dimensions of their object.

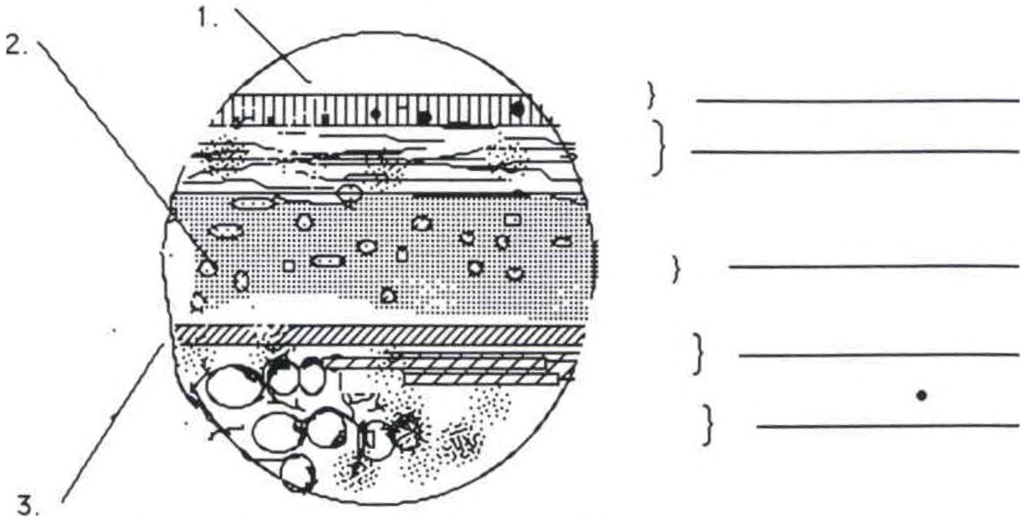
5. At the close of class, teams will secure their original sections and confer with each other to determine the extent of accuracy.



Name________________

Advanced Biology

Sample Histology quiz



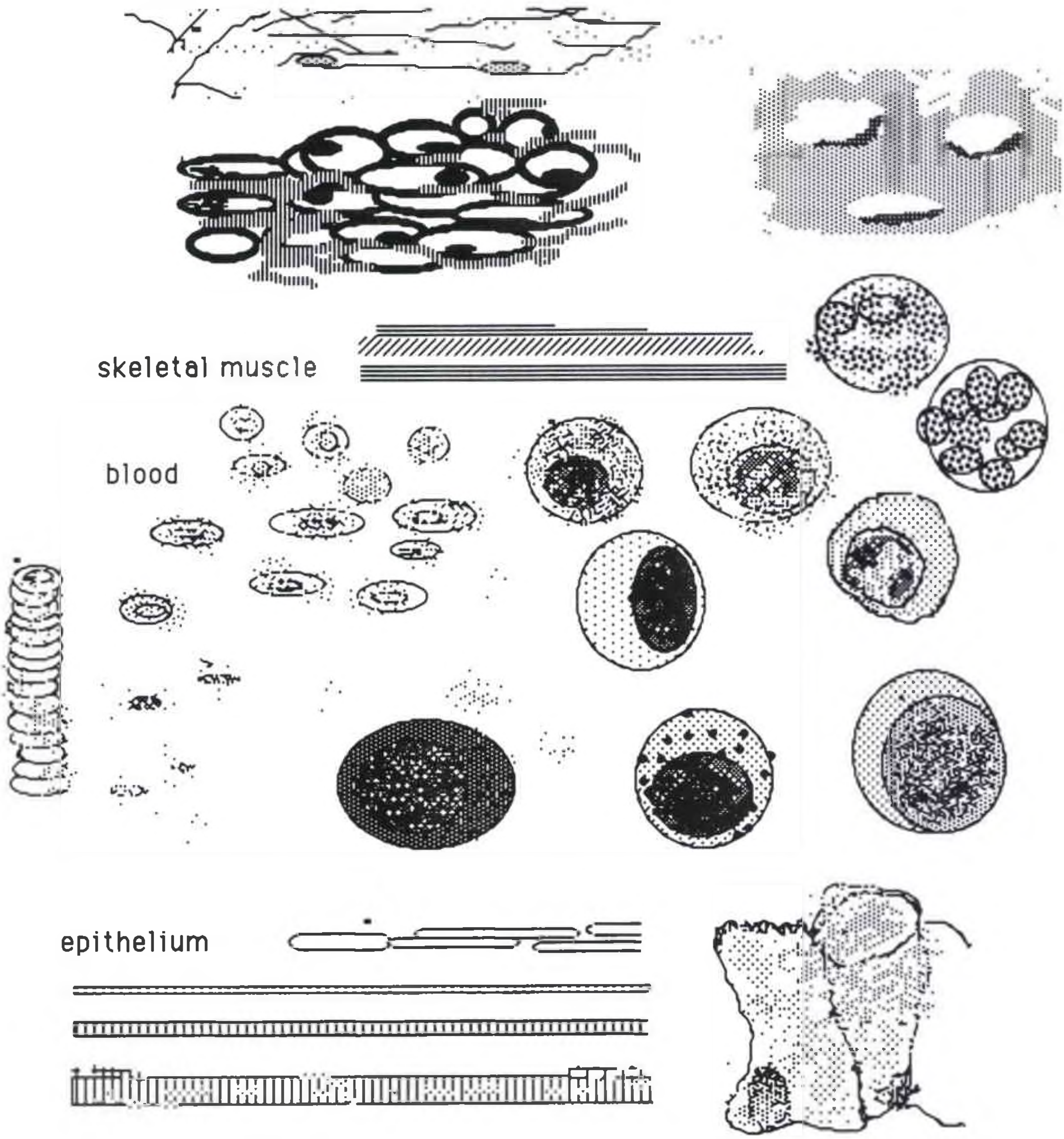
Esophagus c.s. 400x

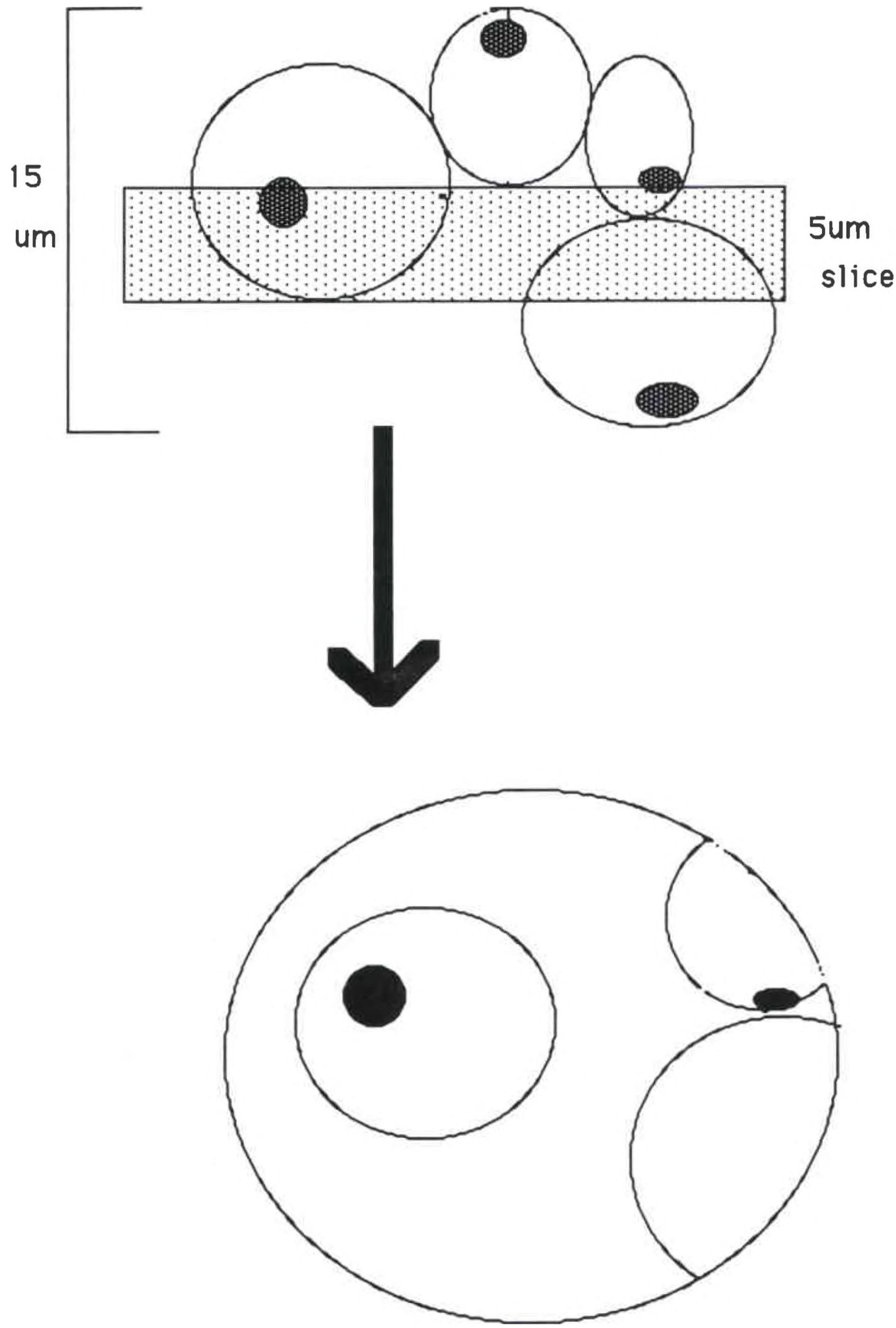
1. identify the cell indicated by arrow #1 : ______________________

2. " " #2: ______________________

3. " " #3: ______________________

4. Identify the five regions shown in the blanks to the right of the brackets.


skeletal muscle
blood
epithelium


15
um
5um
slice