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STRUCTURED LEARNING AND TRAINING ENVIRONMENTS--A PREPARATION LABORATORY FOR ADVANCED MAMMALIAN PHYSIOLOGY.

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A PREPARATION LABORATORY WAS DESIGNED TO FAMILIARIZE STUDENTS IN ADVANCED MAMMALIAN PHYSIOLOGY WITH LABORATORY SKILLS AND TECHNIQUES AND THUS SHORTEN THE TIME THEY SPEND IN SETTING UP ACTUAL EXPERIMENTS. THE LABORATORY LASTS 30 MINUTES, IS FLEXIBLE AND SIMPLE OF OPERATION, AND DOES NOT REQUIRE A PROFESSOR'S PRESENCE. THE BASIC TRAINING UNIT IS THE INDIVIDUAL LEARNING CARREL, EQUIPPED WITH KODAK CAROSEL MODEL AV 900, VIKING DECK TAPE, KOSS HEADPHONES, AND 16" X 16" CARDBOARD SCREENS. THREE MOVIE PROJECTORS, A CENTER TABLE AND A STORAGE CABINET COMPLETE THE LABORATORY SETTING. LABORATORIES WERE DEVELOPED IN NINE AREAS OF PHYSIOLOGY. WRITTEN OVERVIEWS, SLIDES, TAPES, SINGLE CONCEPT FILMS, AND LINEAR PROGRAMS PROVIDE THE STUDENT WITH A KNOWLEDGE OF REQUIRED EXPERIMENTAL PROCEDURES. ALTHOUGH THERE WERE NO CONTROL GROUPS TO BE COMPARED, A COMPARISON BASED ON ESTIMATES SHOWED THAT STUDENTS WHO WENT THROUGH PREPARATION LABORATORIES REQUIRED ABOUT 105 MINUTES TO COMPLETE PRE-EXPERIMENT SETUPS AS COMPARED TO 135 MINUTES FOR STUDENT NOT USING THE FACILITY. QUESTIONNAIRES ALSO REVEALED STUDENTS' PREFERENCE FOR THE PREPARATION LABORATORIES. THERE WAS NO EVIDENCE THAT PREPARATION LABORATORIES PROVIDED A BETTER KNOWLEDGE OF PHYSIOLOGY. (JO)

Educational Development Program

MICHIGAN STATE UNIVERSITY

EAST LANSING, MICHIGAN

Structured Learning and Training Environments: A Preparation Laboratory for Advanced Mammalian Physiology

Project Report No. 203

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Structured Learning and Training Environments: A Preparation Laboratory for Advanced Mammalian Physiology[1]

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Active participation in the modern university science laboratory, whether it is in biology, chemistry, physics, etc., presents a formidable challenge to the student in terms of the complexity of the equipment and the intricacies of the procedures that must be mastered before he is ready to conduct an "experiment." Students often must spend a large part of the laboratory period familiarizing themselves with equipment, setting up the experiment, learning to operate electronic equipment, assembling mechanical apparatus and, in the case of the "advanced mammalian physiology laboratory," becoming proficient with various, complex, surgical procedures. Consequently, "pre-experiment" time may consume up to fifty percent of the laboratory period because a student's entry behavior (skills and knowledge brought to the laboratory) is inadequate for the learning situation to be efficiently approached. Therefore, students often lack time to observe, study, discuss, and learn the basic principles the experiment was originally designed to teach.

To alleviate this situation the Department of Physiology at Michigan State University began the development of a training system designed to provide

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[1]The preparation laboratory described in this document is one of a series of structured learning and training environments (SLATES) under development at Michigan State University with the support of the Educational Development Program.

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students with appropriate skills and orientation before they approached the experimental phases in the "advanced mammalian physiology laboratory." This method involved the development of a preparation laboratory, isolated from the traditional experimental or action laboratory, and conforming to the following criteria:

1. Be limited to 30 minutes.
2. Be flexible enough to allow the treatment of a great variety of subjects and procedures with clarity and brevity.
3. Be available at times convenient to the student.
4. Not require the presence of a professor.
5. Possess simplicity of operation.

It was proposed to the Educational Development Program at Michigan State University that a preparation laboratory be developed for Advanced Mammalian Physiology and other departmental offerings and that it be structured to provide independent study using multi-media techniques, including linear programs. The proposal was accepted and funds were provided.

Procedure

The initial action was the formation of a production team[1] which would determine the basic procedure for the development of the preparation laboratories. Their first step was specification of objectives of the action laboratories. From these objectives the entry behaviors for the action laboratories were determined.

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[1]Production team included the authors, Dr. Robert H. Davis, Director of Learning Service and Dr. Horace Hartsell, Associate Director of the Instructional Media Center.

Once these two elements had been defined (i.e. action laboratory objectives and entry behaviors), the requirements of the preparation laboratory could be identified further in the following sequence:

1. Preparation Laboratory Objectives.
2. Entry behavior into the Preparation Laboratory.
3. Training.
4. Exit behavior from the Preparation Laboratory (knowledge and skills taken from the laboratory).

From this it can be readily seen that the exit behavior from the preparation laboratory corresponded to the entry behavior for the action laboratory (Figure 1).

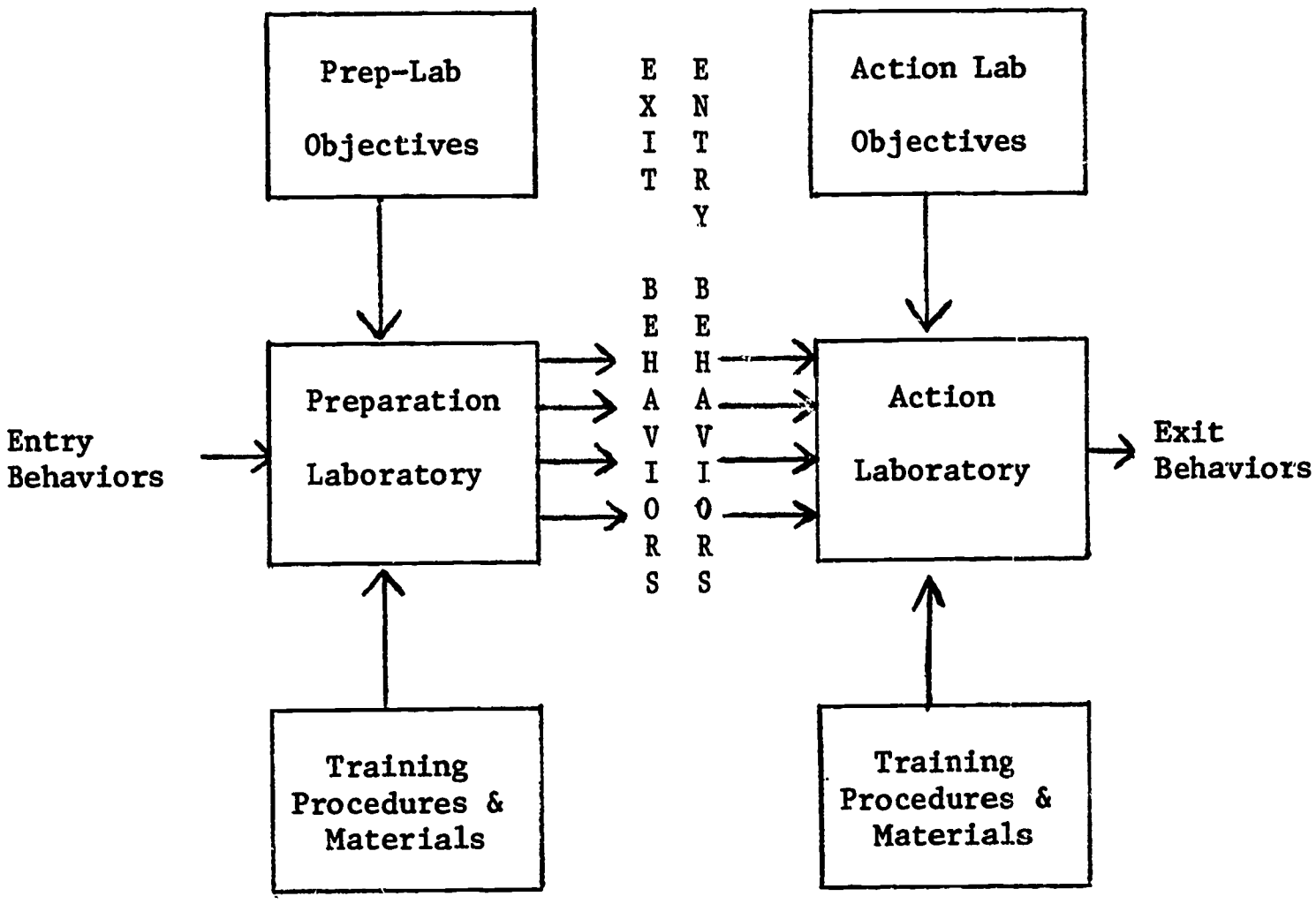


Figure 1

Schematic diagram illustrating the relationship between exit and entry behaviors, objectives, and training procedures for the preparation and action laboratories.

The flow of events illustrated in Figure 1 provided the basic format for the development of detailed objectives, entry, and exit behaviors. Earlier experimental "write-ups" for action laboratories were studied and objectives re-identified; the general procedure is illustrated in Table 1. This table was developed for the sixth experiment in the series on the Exposed Dog Heart and is only one of many pages constructed for this experiment.

Having stated the objectives of an action laboratory exercise and its corresponding preparation laboratory, the next step was to decide what types of instructional media would be best to train students for the desired exit behaviors from the preparation laboratory. An example of the flow charts used to plan media application is shown in Table 2. In the left hand column possible media are listed and in the center is a statement of the task to be considered.

As a final step, an overview chart (list of procedures) was compiled from the preparation laboratory objectives (Table 3). The example of an overview chart shown in Table 3 is for Preparation Laboratory 6. For each general heading, e.g., "artificial respiration," one picture was selected to illustrate the general topic. Overviews were also valuable for orienting members of the production team, who were not physiologists, to various experimental procedures.

When the above procedures had been completed for the first two preparation laboratories, a tentative production schedule was drawn up and production of slides, single concept films, programs, etc. was begun.

Facilities

The basic training unit was the individual learning carrel (semi-enclosed booth). A design was approved and ten carrels ordered.

Table 1

An Example of Entry and Exit Behaviors and Objectives
for Part of a Single Laboratory Exercise.

PHYSIOLOGY - 501 LABORATORY - 6 THE EXPOSED DOG HEART

Action Laboratory		Preparation Laboratory			
Objectives	Entry Behavior	Objectives	Entry Behavior	Training	Exit Behavior
1) Can operate a setup for artificial respiration in the dog.	1) Can describe the setup for artificial respiration in the dog.	1) Teach to be able to describe the setup for artificial respiration in the dog.	1) Can anesthetize a dog. a) Can intubate a dog.	1) Train to be able to describe the setup for artificial respiration in the dog.	1) Can describe the setup for artificial respiration in the dog.
2) To be able to expose the heart of a dog by means of a mid-line incision thru the sternum.	2) Can describe how to expose the heart of a dog by means of a mid-line incision thru the sternum.	2) To teach to be able to describe how to make a mid-line incision thru the sternum of a dog.	2) Can record E.C.G. a) Can cannulate the carotid artery. b) Can isolate the vagus nerves. c) Can isolate the femoral vein.	2) Train to be able to describe how to make a mid-line incision thru the sternum of the dog.	2) Can describe how to make a mid-line incision thru the sternum of the dog.

Table 2

Flow Chart of Preparation Laboratory Media

PHYSIOLOGY - 501 LABORATORY - 6 THE EXPOSED DOG HEART

Written	Artificial Respiration - 1
Audio	state reason for artificial respiration → show pump → describe operation
Slides	show dog, Grass, pump, etc.
Motion Picture	
Models	
Program	

use balloon

Table 3

Overview of Preparation Laboratory 6

A. Artificial Respiration

1. Picture of pump and laryngeal tube.

B. Chest Surgery

1. Picture of chest open and sutures holding it open.

C. Isolation and occlusion of arteries and veins

1. Picture of inferior vena cava with cord around it.

D. Pericardial sac pressure

1. Picture of sac lifted up and hole cut in it and about to insert catheter.

E. Pericardial sac hammock

1. Picture of procedure completed.

F. Arrhythmias

1. Picture of normal E.C.G. and abnormal E.C.G. under it and overlays.

Four pieces of equipment were placed in each carrel.

1. Kodak Carousel Model AV 900 with remote control attachment.
2. Viking deck tape unit.
3. Koss headphones.
4. 16" x 16" cardboard screens for the Kodak Carousel.

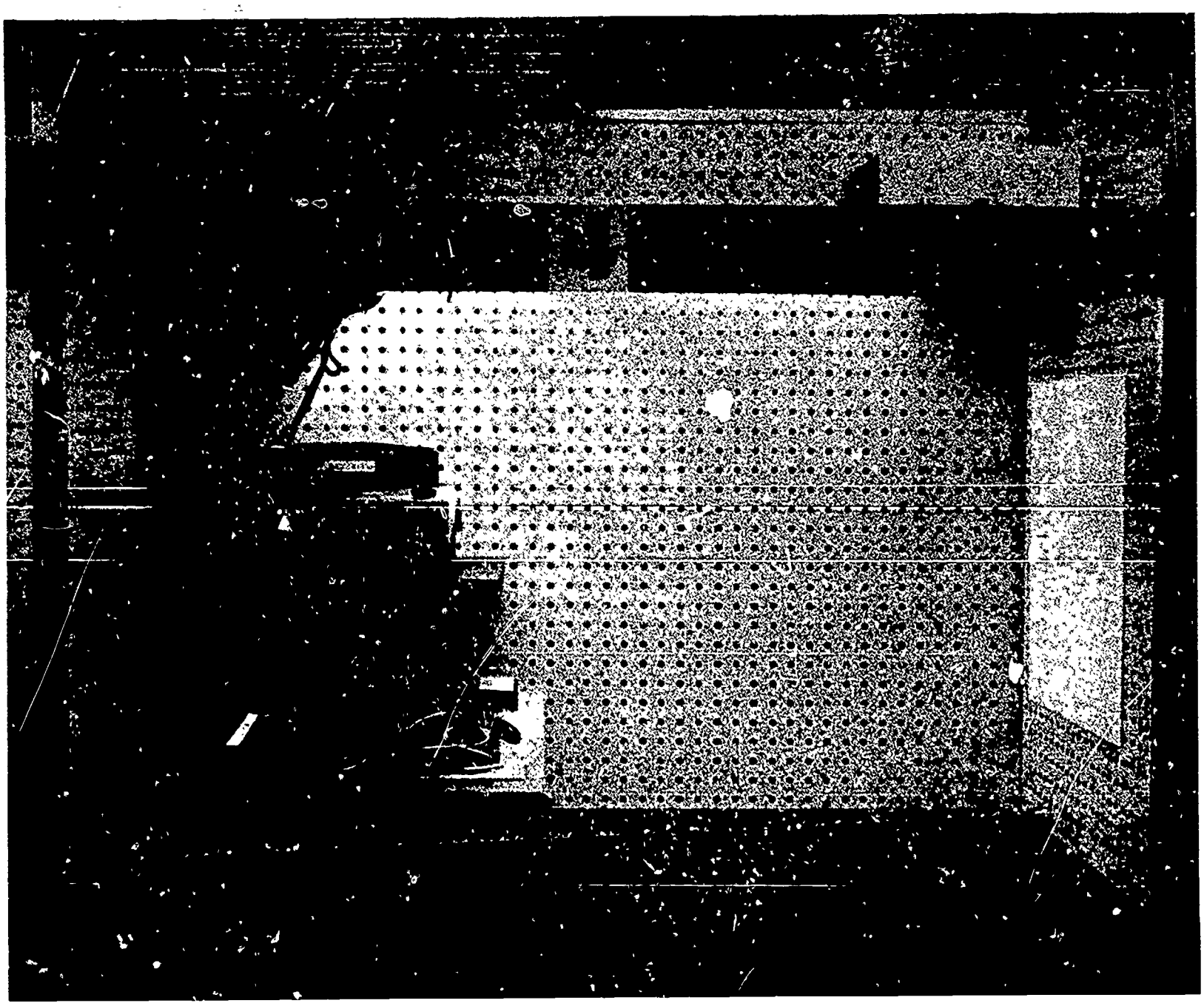
Equipment specific to the carrel function were selected: the AV 900 Model Kodak Carousel was chosen because of its heavy duty motor requiring minimal maintenance; the Viking decks included only playback units, thereby reducing costs and preventing students from inadvertently erasing tapes. To minimize distractions due to room noise and to create an atmosphere in which students could concentrate on materials on hand, headphones, rather than external speakers, were used.

A photograph of a completely equipped carrel is shown in Picture 1. Shelves supporting Kodak Carousels were made of 5/8 inch laminated plywood, covered with wood simulated vinyl paper and held in place by steel L-rods.

Five other pieces of equipment completed the basic setup in the preparation laboratory: three "super-eight" technicolor continuous feed movie projectors, a center work table and a sixteen foot storage cabinet. Pictures 2 & 3 show these items, the arrangement of carrels and the desk where students signed in and out of the preparation laboratory. Frosted glass partitions were used to isolate the preparation laboratory from the rest of the room.

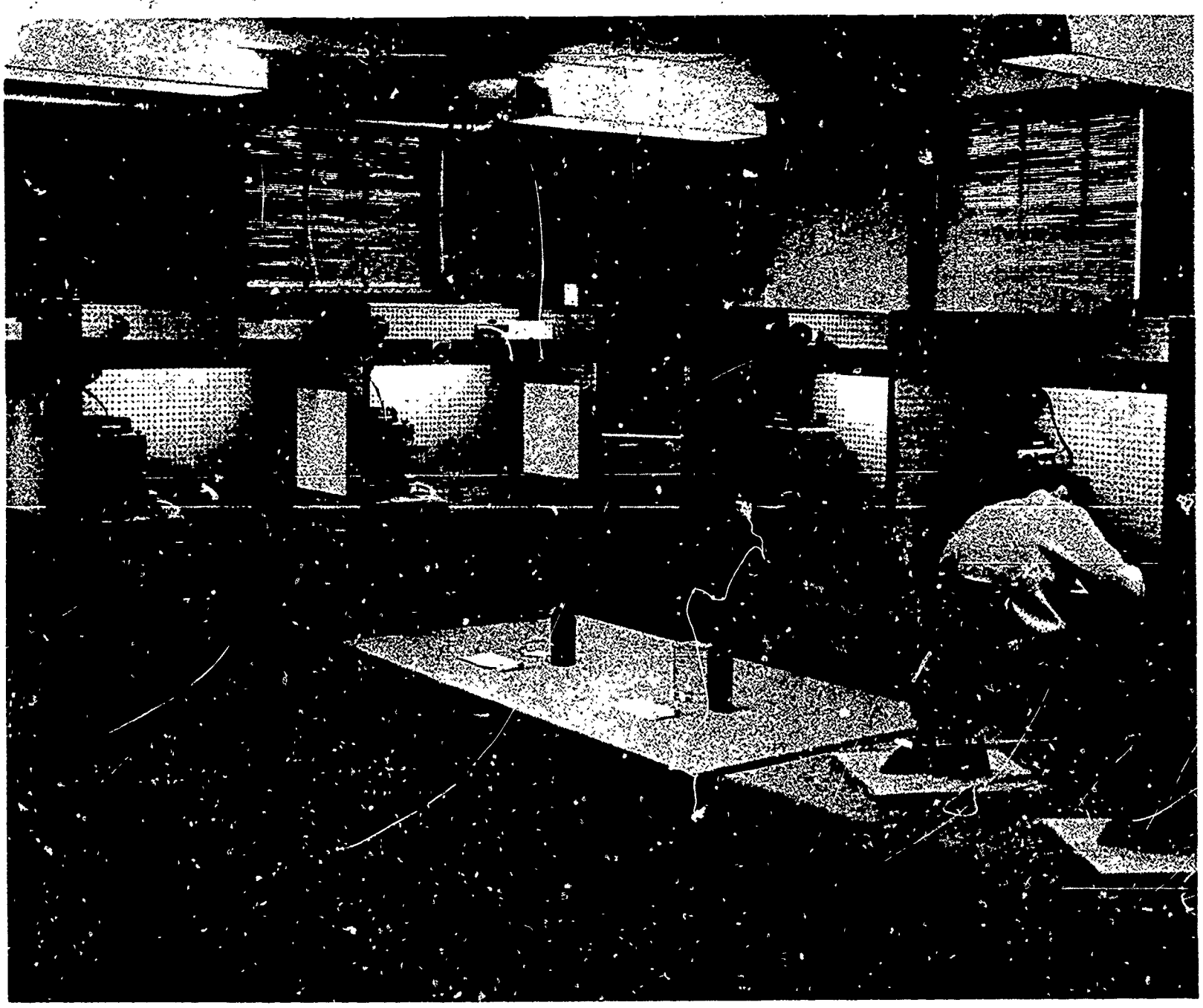
Laboratory Procedure

Since nine action laboratory experiments are performed in the first quarter of the advanced mammalian physiology course (Physiology 501), nine different preparation laboratories were developed in the following areas:



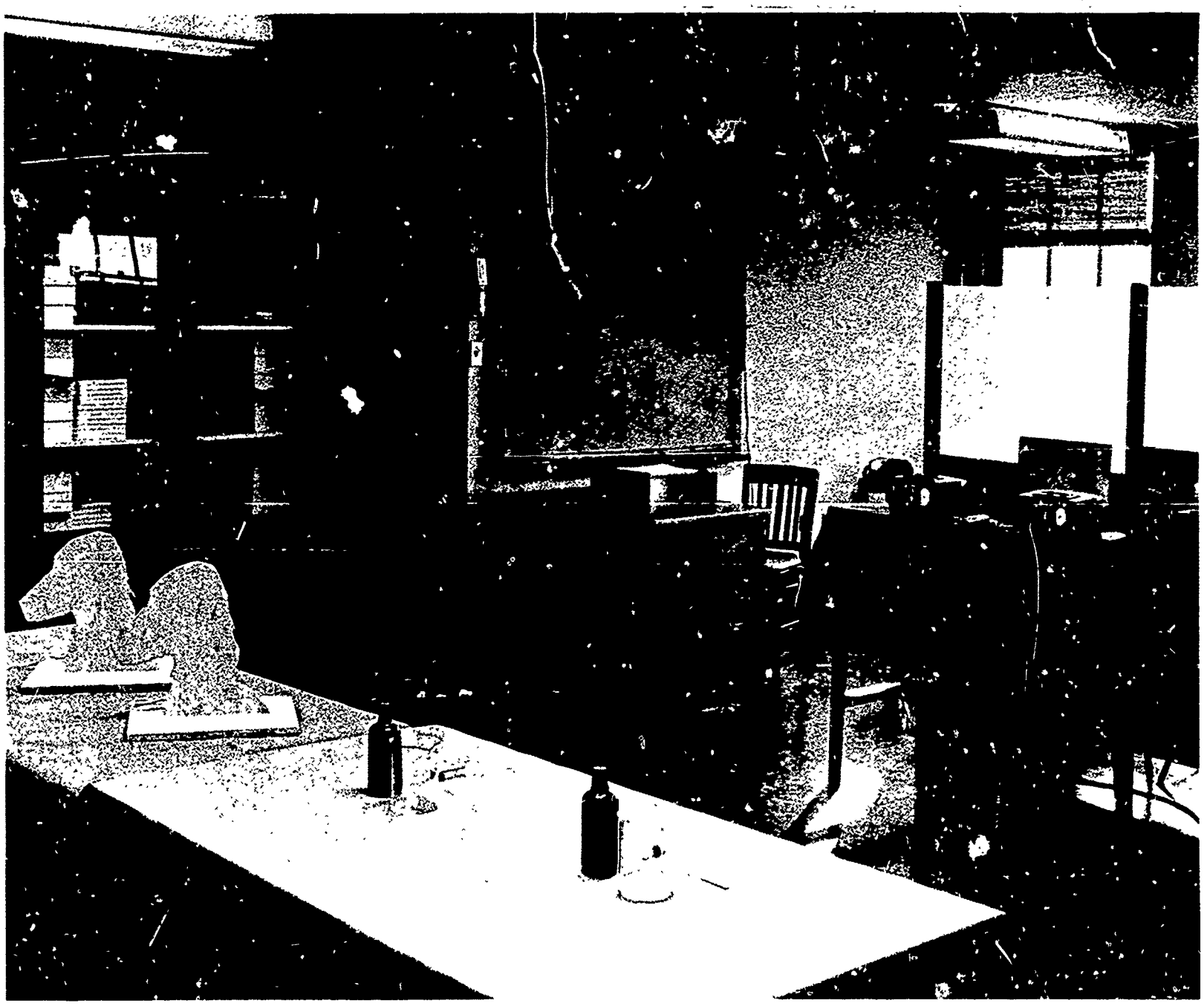
Picture 1

Equipped Carrel



Picture 2

Preparation Laboratory



Picture 3

Preparation Laboratory

1. Osmosis
2. Blood - Coagulation, Osmotic Properties and Volume Relationships
3. Muscle Contraction
4. The Turtle Heart
5. Control of Blood Pressure in the Dog
6. The Exposed Dog Heart
7. Blood Pressure, Heart Sounds, and E.C.G. in Man
8. Respiration in the Dog
9. Renal Functions in the Dog

The preparation laboratories dealt with many different subjects including the "pithing" of the frog, operation of the Grass polygraph machine, open chest surgery, and so on. Because of the complexity and diversity of this material, two procedures were initiated:

1. Material was presented in the same order in the preparation laboratory as it would be in the action laboratory.
2. Students were given a written "overview" of the material to be covered at the beginning of the preparation laboratory, which included the title of the experiment and a list of subjects to be covered (Figure 2).

Instructions at the bottom of the overview sheet always directed students to put on the headphones and turn on the tape units. The introductory dialogue for the sixth preparation laboratory, which is typical of all the others, began as follows:

> "This is preparation laboratory 6. Today we want to prepare you for the sixth action laboratory which is concerned with the exposed dog heart. First, let's take a look at the overview slide. Turn on the slide projector and advance the machine to Slide 1."

The first slide always provided an overview to supplement the written material. The accompanying dialogue briefly outlined each procedure for the student. The overview slide for preparation laboratory 6 and its associated dialogue is illustrated in Figure 3.

PHYSIOLOGY 501 PREPARATION LABORATORY

EXPERIMENT 6 THE EXPOSED DOG HEART

I. Subject Matter Covered

A. Canine sternotomy

B. Isolation and occlusion of great vessels

C. Pericardial sac pressure

D. Pericardial sac hammock

E. Artificial respiration

F. Cardiac arrhythmias

II. Instructions

A. Put on the headphones

B. Turn on the tape recorder

Figure 2

Overview of Experiment Six

OVERVIEW

I. CANINE STERNOTOMY

II. ISOLATION AND OCCLUSION OF GREAT VESSELS

A. INFERIOR VENA CAVA

B. SUPERIOR VENA CAVA

C. AORTA

III. PERICARDIAL SAC PRESSURE

IV. PERICARDIAL SAC HAMMOCK

V. ARTIFICIAL RESPIRATION

VI. CARDIAC ARRHYTHMIAS

Figure 3

"The first procedure you will study today is the correct procedure for canine sternotomy. This will be followed by the technique for occluding the superior and inferior vena cava and the aorta. Third on the list is the pericardial sac pressure experiment which is followed by the pericardial sac hammock procedure. The two remaining items are: artificial respiration and cardiac arrhythmias. Now lets look at a representative slide of each of these -- Slide 2."

Following the overview slide, students were shown photographs depicting each procedure listed in the overview slide. (To help the reader visualize what is involved in this approach, a picture of the completed sternotomy and its dialogue is given in Picture 4.) The last slide in this series listed the duties of each team member. As seen in Table 4, groups consisted of five students, each with separate duties and responsibilities[1] (upon entering the preparation laboratory, each student would refer to a posted list informing him of his team role that week). The same five students worked together for the entire quarter, but their team positions rotated each week.

Following this orientation material, the first subject listed in the overview slide (canine sternotomy for Preparation Laboratory 6 -- see Figure 3) was described in detail. For many of the procedures, single concept films were developed; in these cases students were told first to view the single concept film on the procedure. This gave them the "gestalt" -- a feeling for the entire procedure and insight into the "motion" involved. Students then returned to the carrels and followed the same procedure through a step at a time using the slides and audio tapes which explained each slide. A short sequence of pictures and dialogue taken from the canine sternotomy procedure is contained in Pictures 5 a, b, & c.

In addition to slides, tapes, and single concept films, linear programs were written for each preparation laboratory to cover largely "cognitive" material. In the fifth, sixth, and seventh preparation laboratories these

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[1]Team duty charts were also posted in the action laboratory, thus eliminating the necessity of the student having to memorize his specific duties.

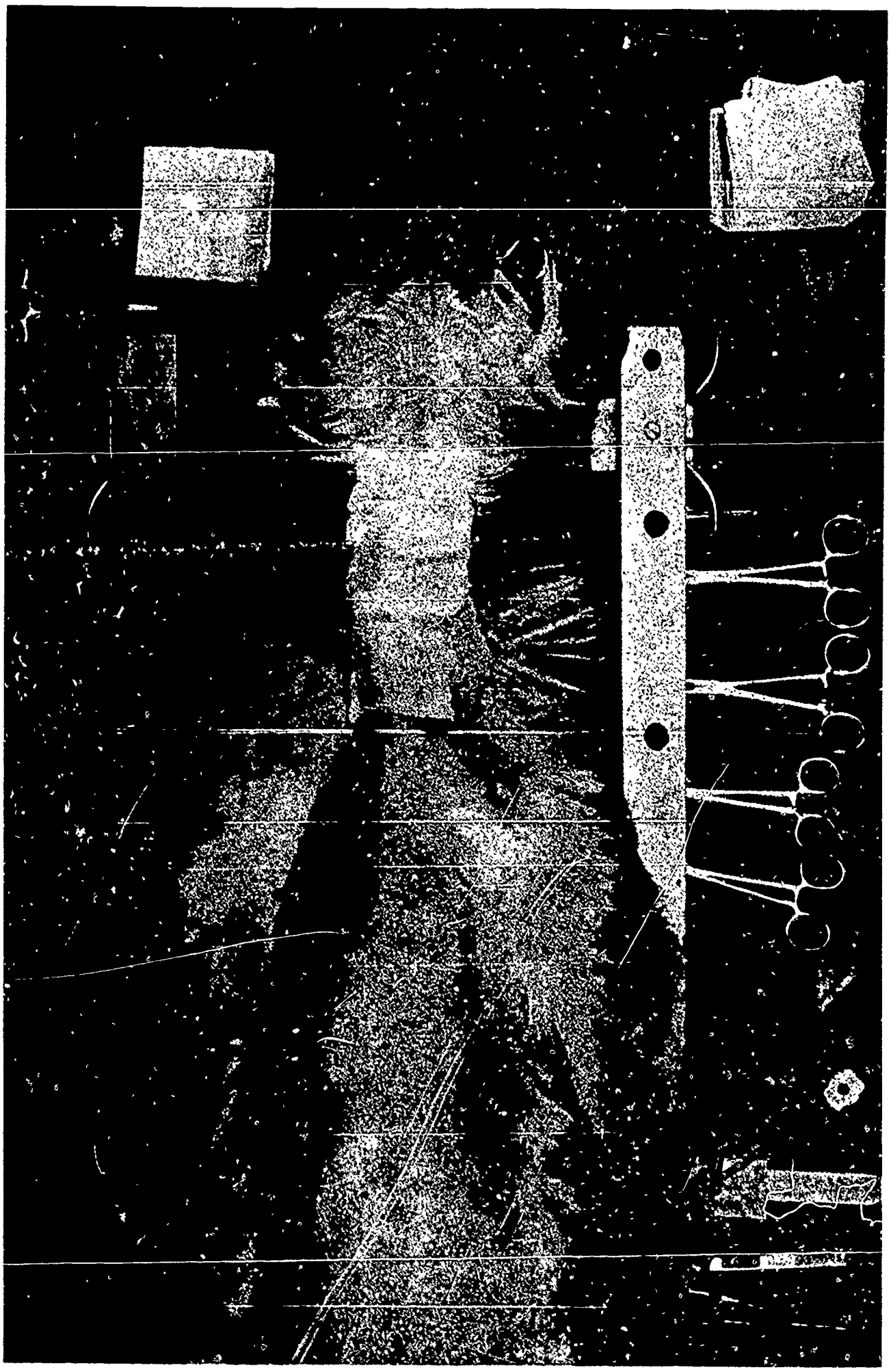
Picture 4

"This is what your setup should look like if you perform the sternotomy correctly -- Slide 3."

Table 4

Team Duties for Preparation Laboratory 6

SURGEON	1. PERFORM THE STERNOTOMY 2. ISOLATE AND OCCLUDE THE GREAT VESSELS 3. PERFORM THE PERICARDIAL SAC PRESSURE SURGERY
SURGICAL ASSISTANT	1. CANNULATE THE CAROTID ARTERY AND ISOLATE THE VAGUS NERVE 2. AID THE SURGEON 3. PERFORM THE PERICARDIAL SAC HAMMOCK SURGERY
ANESTHETIST	1. ANNESTHETIZE AND INTUBATE THE DOG 2. RESTRAIN THE DOG AND CANNULATE THE FEMORAL VEIN 3. INSTITUTE AND MAINTAIN ARTIFICIAL RESPIRATION
RECORDER	1. CALIBRATE THE GRASS MODEL 5D POLYGRAPH 2. HOOK UP THE LEADS TO MAKE AN E.C.G. AND MAKE ALL RECORDINGS
CIRCULATOR	1. ASSIST THE ABOVE STUDENTS WHEREVER NECESSARY 2. LOCATE, IN YOUR TEXTBOOK, THE MATERIAL PERTINENT TO THIS EXPERIMENT



Picture 5a

Slide 9

"Here we have the dog anesthetized, intubated, restrained, and the carotid artery isolated -- Slide 10."

Picture 5b

Slide 10

"A mid-line incision is made from the top of the sternum to just below the inferior end of the sternum -- Slide 11."

Picture 5c

Slide 11

"The incision is now taken down to the bone along the entire length of the sternum. It is absolutely imperative that you remain in the exact mid-line of the sternum during this dissection and throughout the rest of the surgery. The reason for this is that two very large arteries lie just under the sternum and just lateral to the mid-line. They are the left and right internal thoracic arteries -- Slide 12."

linear programs were combined with "overlays" to explain better normal and abnormal electrocardiograms. A sample from a linear program and its corresponding overlays are shown in Figure 4 and Picture 6.

Where feasible, psychomotor training was provided using models and simulation. For this, students were directed to the center table where they might, for example, muzzle a model of a dog's head after following the procedure on slides and tape (Picture 7).

Operation of Preparation Laboratory

Prior to their first laboratory, students were given an orientation period in which they were introduced to the preparation laboratory and taught to operate the audio-visual equipment.

Undergraduate students were hired to work in the lab which was open 5 hours per day, Monday through Friday. Upon entering the laboratory, a student's time card (Figure 5) was taken from the file and the following facts recorded:

1. Date.
2. Number of the experiment he was previewing.
3. The time he entered the laboratory.
4. The carrel to which he was assigned.

Upon leaving the laboratory, the time card was returned and the time recorded. From this, the time each student spent in the preparation laboratory for each experiment and the total time he spent in the laboratory during the entire course could be calculated.

29. Premature ventricular systole is similar to premature atrial systole except that in the former the ectopic focus is in one of the _____ and in the latter it is in one of the _____.

ventricles

atria

30. Since in premature ventricular _____ the ectopic focus is in one of the _____ there is no _____ wave, in this abnormal section of the E.C.G.

systole
ventricles
P

31. However, the remainder of this abnormal cycle in the E.C.G. of premature ventricular systole is the same as in premature atrial systole even to the presence of the _____ pause.

compensatory

32. Also, the reason for the compensatory _____ in premature ventricular systole is the same as it is in _____ _____.

pause
premature
atrial systole

33. The third arrhythmia is atrial flutter. In this condition the atrial rhythm is regular. However, the atrial rate ranges between 250 and 350 beats per minute instead of the normal 70-80 beats per minute.

flutter

34. In atrial _____ the excessive number of impulses do not originate in the _____ _____ node.

S A

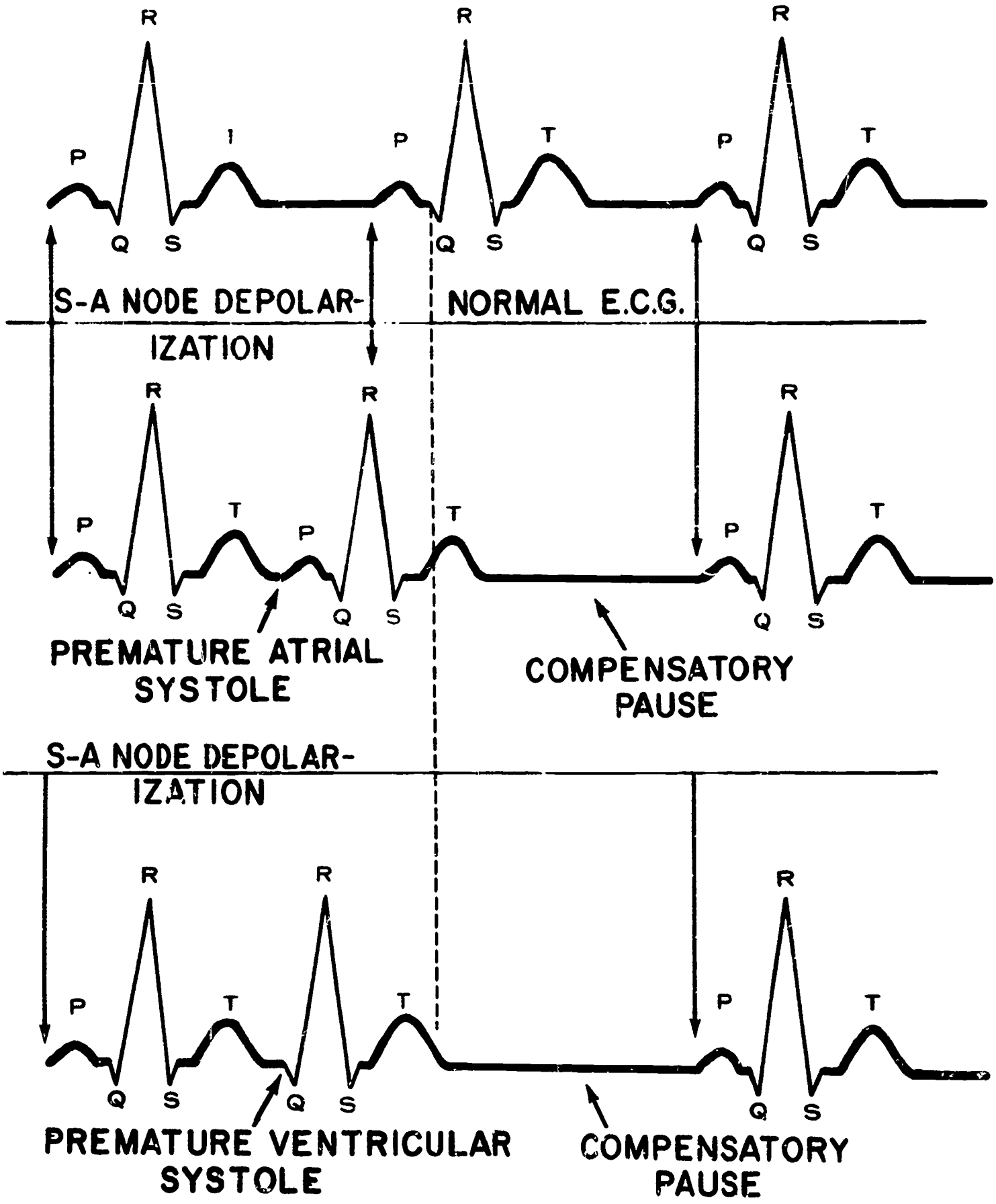
REMOVE THE PRESENT OVERLAYS AND PLACE BASE II OF THE OVERLAYS IN PLACE.

35. Also, in _____ _____ the atrial ____ waves are much longer than normal.

atrial flutter
P

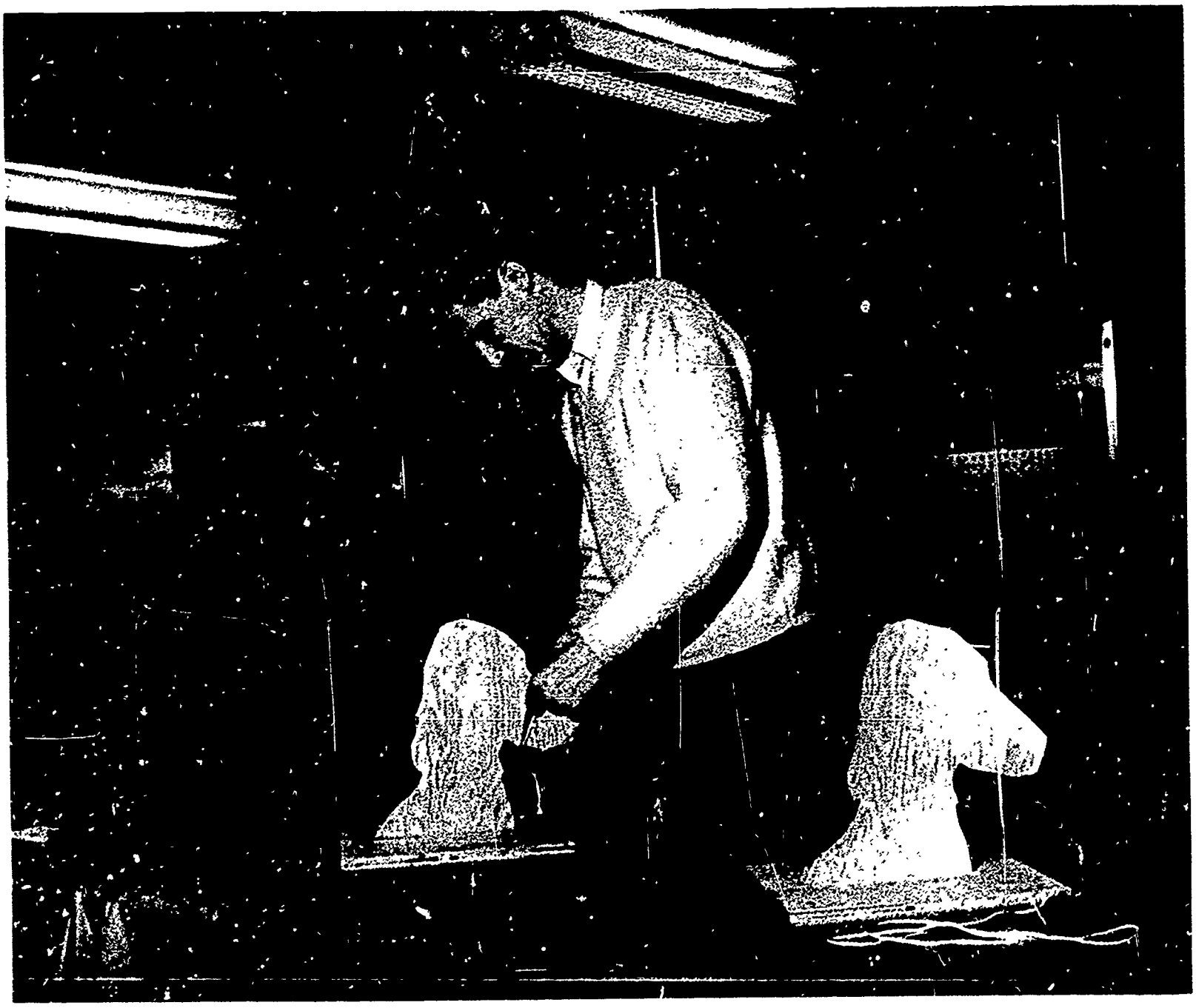
Figure 4

Linear Program



Picture 6

Base I and Its Overlays



Picture 7

Dog Muzzling

Physiology 501					Preparation Laboratory	
Date	Prep Lab Number	Time			Carrel Number	
		In	Out	Total		

Figure 5

Time Card

It was the responsibility of the undergraduate student help to organize the preparation laboratory for each new experiment and to assist students in the operation of equipment. Equipment trouble was kept to a minimum by preparing the carrels before assigning students to them, including:

1. Drums of slides were placed on Carousel projectors and set at zero.
2. Tapes were threaded on Viking decks.
3. Headphones were plugged into Viking units and placed on the top shelves of carrels.

Before leaving the preparation laboratory the student was instructed to:

1. Turn the drum of slides back to zero.
2. Place the projector "on-off switch" to the fan position.
3. Turn off the tape recorder <u>but not to rewind the tape</u>.
4. Put the headphones back on the top shelf of the carrel.

After a student had signed out and his time card was filed, the laboratory assistant would set up the carrel for the next student.

Results

Attendance in the preparation laboratory of students completing the course was 100%. Time required for each preparation laboratoy was determined from the time cards and the average length of time per session calculated (Table 5).

Table 5

Mean Time Required for Completion of Each Preparation Laboratory

Preparation Laboratory	Title of Laboratory	Time (Minutes)
1	Osmosis	47.1
2	Blood	37.0
3	Muscle Contraction	38.6
4	Turtle Heart	26.2
5	Blood Pressure - Dog	61.8
6	Exposed Heart - Dog	50.4
7	Blood Pressure - E.C.G. - Man	10.4
8	Respiration - Dog	15.7
9	Renal Function - Dog	19.8
	Overall Average	34.1

Six of the nine action laboratory experiments required major setup procedures ("pre-experiment" procedures) and the time from the beginning of the laboratory period until all of the students had completed their setups was recorded (Table 6).

Table 6

Setup Time for Six of the Nine Action Laboratories

Action Laboratory	Title of Laboratory	Setup Time (Minutes)
3	Muscle Contraction	45
4	Turtle Heart	45
5	Blood Pressure - Dog	90
6	Exposed Heart - Dog	90
8	Respiration - Dog	65
9	Renal Function - Dog	90
	Overall Average	71

Unfortunately, no comparable times exist for groups without the benefit of the preparation laboratory. However, a survey of the professors and graduate assistants who have been instructing in the action laboratories

over the past three years provided the following rough estimates of setup time ("pre-experiment" time) without preparation laboratories.

1. Estimated minimum setup time for experiments 3, 4, and 8 = 120 minutes.

2. Estimated minimum setup time for experiments 5, 6, and 9 = 150 minutes.

3. Average estimated setup time for experiments 3, 4, 5, 6, 8, and 9 = 135 minutes.

These estimates include the time required to explain and to demonstrate procedures as well as the time required by the students to perform the procedures.

When the average time spent in the preparation laboratory (Table 5 - 34 minutes) is added to the mean setup time in the action laboratory (Table 6 - 71 minutes), students who had the benefit of the preparation laboratory required an average of 105 minutes to complete their pre-experiment setups compared to 135 minutes (estimated average - see above) for students not using the facility; a net savings of 22% for each laboratory.

Consequently, it was possible to reduce the action laboratory from 5 hours to 4 hours. The hour saved was used for discussion of the experimental results. It may be possible in the future to program the results and discussion of the physiological principles involved in the action laboratory into a structured learning and training environment similar to the preparation laboratory, providing students with both a preparation period and a post-experimental period in one SLATE.

A questionnaire was used to assess student attitudes toward action laboratories. Comparisons were drawn among 3 groups including: 1) students from Physiology 502, who did not have the benefit of the preparation laboratories, 2) students from Physiology 501, who did have the preparation laboratories, and 3) students from Physiology 502, who did not have the preparation

laboratory (Table 7).[1] Lack of control data for students taking PSL 501 without prep labs precluded comparisons with the experimental group. PSL 501 and PSL 502 both deal with mammalian physiology, are cons· ered to be comparable in format and difficulty, are taught by the same instructors, and include virtually identical student bodies.[2]

Despite the use of an imperfect control, it is clear from an inspection of Table 7 that the expediency of the preparation laboratory concept is favored. Discussions with faculty and graduate assistants substantiate this general impression.

Further support for the preparation laboratories is provided by a second questionnaire (Table 8) administered to students <u>after</u> they had taken PSL 502 <u>without</u> the preparation laboratories (this group had previously had PSL 501 <u>with</u> the preparation laboratory). Again, it is obvious these students also favored the use of the preparation laboratory.

Whereas the preparation laboratories resulted in significant savings of student time (Table 6) there is no evidence that preparation laboratories provided a better knowledge of physiology as indicated by the result of a thirty-five item multiple choice test given without notice to the two groups of students. These results are consistent with many so-called "methods experiments" in education which fail to demonstrate on objective tests consistent and significant differences favoring one approach over another.

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[1]This latter group of PSL 502 students was the same group of students who had PSL 501 with the preparation laboratory.

[2]Preparation laboratories for PSL 502 are now under development, and since control data for PSL 502 does exist, it should be possible to make more satisfactory comparisons in the future.

Table 7

Comparison of Imperfect Control (See Text) and Experimental Groups on Student Questionnaire. Percent of Students Agreeing, Uncertain, and Disagreeing with Each Item.

	PSL 502 (Spring '66)*			PSL 501 (Summer '66)**			PSL 502 (Fall '66)***		
	Agree	Uncertain	Disagree	Agree	Uncertain	Disagree	Agree	Uncertain	Disagree
1. This has been one of the most interesting and stimulating laboratories I've had in college.	31	22	47	79	9	12	14	13	73
2. Lecture material and laboratory experiments were closely coordinated.	35	21	44	63	7	30	41	23	36
3. The members of my surgical team always knew what they were expected to do.	20	18	62	62	13	25	18	18	64
4. I learned very little physiology in the laboratory.	34	32	34	7	14	79	53	16	31
5. I frequently found my attention wandering during laboratory hours.	67	13	20	12	10	78	55	14	21
6. Laboratories were an exciting learning experience.	17	32	51	72	13	15	12	39	49
7. A great deal of planning obviously went into the laboratory experiments.	10	33	57	74	21	5	21	32	37
8. There was always plenty of time for my group to complete experiments and discuss results.	64	12	24	44	7	49	89	4	7
9. I frequently found myself thinking about the laboratories outside of class.	23	20	57	63	16	21	18	25	57
10. A substantial amount of laboratory time was wasted each week because students didn't know what procedures to follow.	72	10	18	12	14	74	63	10	27

	PSL 502 (Spring '66)*			PSL 501 (Summer '66)**			PSL 502 (Fall '66)***		
	Agree	Uncertain	Disagree	Agree	Uncertain	Disagree	Agree	Uncertain	Disagree
11. The labs were not a particularly valuable part of the course.	39	25	36	8	8	84	59	16	23
12. Laboratory exercises were well organized.	7	28	65	70	23	7	23	24	53
13. When I encountered difficulty performing an experiment, assistance was always available.	71	12	17	79	9	12	78	6	16
14. There was frequently confusion in regard to the physical or mechanical setup of the experiments.	68	14	18	17	11	72	54	15	31
15. I learned more physiology in the laboratory than in the lecture.	3	7	90	16	26	58	2	1	97
16. At the beginning of the laboratory hour, I always knew what my specific duties were.	10	17	73	93	3	4	18	19	63
17. Too much time was devoted to preparing for and conducting experiments relative to the amount I learned.	64	16	20	24	20	56	50	31	19

* PSL 502 Spring '66 - No Prep Lab available.
** PSL 501 Summer '66 - Prep Lab available.
*** PSL 502 Fall '66 - No Prep Lab available.

Results of Questionnaire Administered to a Group of Students Which Had One Term of Physiology With the Preparation Laboratories (PSL 501) and One Term of Physiology Without the Preparation Laboratories (PSL 502).

	PSL 501 (Summer '66) vs PSL 502 (Fall '66)*		
	Agree 1 & 2	Uncertain 3	Disagree 4 & 5
1. Preparation Labs were a waste of time.	4	4	92
2. I learned about the same amount of Physiology from an experiment with or without the preparation laboratory.	8	4	88
3. I was about as well prepared for the experiments in PSL 502 as in PSL 501.	4	8	88
4. Preparation laboratories would be a valuable addition to PSL 502.	84	8	8
5. Because there was no preparation laboratory, PSL 502 was not as interesting as it might have been.	59	26	15
6. As a result of the preparation labs, surgical teams were better prepared in PSL 501 than in PSL 502.	94	2	4
7. Experiments were better planned in PSL 502.	4	11	85
8. Considerable time was lost in PSL 502 because there were no preparation labs.	64	13	23
9. The preparation labs in PSL 501 did not add to my interest or increase my enthusiasm for experiments.	4	8	88
10. Preparation laboratories would be a valuable addition to many science courses.	83	13	4
11. It would have been easier to set up my experiments in PSL 502 if there had been a preparation laboratory.	79	11	10
12. Preparation laboratories helped to reduce confusion in the action laboratories.	94	4	2
13. Very little experimental set up time was saved as a result of the preparation laboratories.	14	2	84

*The Prep Lab was available in PSL 501 (Summer 1966) but there was no Prep Lab for PSL 502 (Fall 1966).

Summary

Because students were frequently not prepared to conduct complex experiments in the advanced mammalian physiology laboratory, a special multi-media structured "preparation" laboratory was developed. In this preparation laboratory students previewed experiments and acquired the necessary skills and information to conduct the experiments successfully.

On the basis of evaluations, questionnaires, and examinations, the following salient points were noted:

1. Student setup time in the action laboratory was reduced by approximately one hour.

2. Student interest, attitude, and appreciation for the course were greatly improved.

3. Students were overwhelmingly in favor of the development of a preparation laboratory for Physiology 502.

4. Students felt preparation laboratories would be a valuable addition to many other science courses.

5. In terms of knowledge of course content as measured by objective examination, students using the preparation laboratory were not appreciably different from students who did not have the benefit of a preparation laboratory.