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/HORMONES AND HOMEOSTASIS/
AN EDUCATIONAL COMPUTER PROGRAM IN PHYSIOLOGY

by

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B. A., University of Washington, 1978

A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

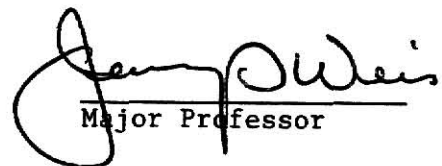
MASTER OF SCIENCE

Department of Biology

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1985

Approved by:


Major Professor

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**THIS BOOK
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I. Introduction

Computer assisted instruction, or CAI, is a rapidly growing field. Since the first primitive CAI systems in the late 1950's and 1960's, CAI has developed to the point where it is found in 50% or more of the U.S. educational systems, with its heaviest use in higher education.¹ Two important breakthroughs in CAI are primarily responsible for this growth. The first is the development of BASIC, a simplified computer language developed in 1959 by John Kennedy. BASIC is now the most widely used language for writing CAI. The second important development was the commercial introduction of microcomputers in 1977. Essentially all CAI is currently designed for the microcomputer, due to its relatively low cost and ease of handling.

Among the most commonly used microcomputers in CAI are the Apple, Radio Shack's TRS-80, and the Commodore. Of these three, the most popular microcomputer for CAI is the Apple.

The major problem in setting up a good CAI system is obtaining good software, or computer programs. Although there is an abundance of CAI software, very little of it is of sufficient quality to be of much use in education. Much of it consists of simple drill and practice routines or of written material. These programs make little or no use of the computer's greatest educational asset - the ability to allow the student to participate actively, or interact, in the educational process. Another powerful educational aspect of computers is their ability to simulate real life situations in such a way that the student can "experiment" with them; this is especially true in the sciences.² For these reasons, then, I have designed "Hormones and Homeostasis" as an interactive program involving physiological simulations.

II. The Role of Computers in the Biology Curriculum

In recent years biology has become an increasing quantitative science. This trend has caused biology to become an increasingly computerized science. Computers are now used in the biochemistry and the ecology lab alike. The computer will likely surpass the microscope as a generally applicable tool of the research biologist.

One important function of computers in the biology curriculum, then, would be to familiarize students with an important tool of biological research. In particular, students could become familiar with the various computer applications found in the biological sciences. These would include data storage and manipulation, direct data collection from instrumentation, complex statistical analysis, and biological modeling and simulation.

With the proper equipment, microcomputers can record everything from the locations most frequently occupied by a fish in a fish tank to the heart rate of a turtle.³ These data can be stored, manipulated and printed out at the student's discretion.

Although the simpler statistical techniques utilized in biology can be performed on a calculator, many complex or repetitive biological calculations (for example, predator-prey interactions over time) are best performed on a computer. Also, computers have the additional benefit of being able to display the results in graphical form.

A major use of computers in biology education is CAI, especially simulations. Simulations are frequently used as adjuncts to laboratory experiments. These biological simulations can provide students with "experiments" that would be too expensive or time consuming to conduct

in an undergraduate or high school biology laboratory. An example of such a simulation is "Protein Mastermind"⁴ in which the computer generates a random polypeptide sequence and the students have to determine the sequence of its amino acids by the use of various protein sequencing reagents. Another simulation designed along these same lines is "Maxam--Gilbert",⁵ which allows the student to determine the length of a short segment of DNA through the Maxam-Gilbert DNA sequencing techniques.

An example of a biological simulation involving a bit more creativity is "Alien",⁶ a simulation of cardiopulmonary physiology. The user must answer a series of physiological questions by performing a series of experiments such as administering exercise, increased or decreased oxygen and CO₂, injection of epinephrine or tranquilizers and so on. The student can experiment on either a human or five fictitious extraterrestrials.

It is clear that a wide range of applications exist for the computer in the biology curriculum. It is our responsibility to see that we make the most of this powerful and versatile educational resource.

III. Objectives and Specifications

"Hormones and Homeostasis" has two main educational objectives. The first is to give students a working understanding of homeostasis, which is often a difficult concept for beginning biology students. The second is to teach students the function of five hormones important in homeostasis - insulin, glucagon, parathyroid hormone, thyroxine and anti-diuretic hormone.

This program is designed for a college freshman biology course, although it could also be used in a beginning physiology course or an advanced high school biology course.

Students using the program should have some familiarity with the concept of hormones. Also, the student should know some basic physiology in order to use the program effectively. For example, the student should understand the concepts of chemical concentration, metabolism, and the function of blood. The student should also be able to read graphs.

"Hormones and Homeostasis" is designed for students with little or no computer background. Students need only know how to turn on the computer.

This program will run on an Apple II E computer or an Apple II + with an expanded memory (64 K). The program is designed to be displayed on a color screen, although it runs perfectly well on a monochrome screen.

IV. Description of Program

"Hormones and Homeostasis" has two major divisions - a test section and a simulation section. The first part of the program, the test portion, consists of instructions on how to use the program and two tests - one on hormones and the other on homeostasis. Each test consists of four multiple choice questions. If the students answer all of the test questions correctly, they have adequate knowledge to understand the simulation portion of the program and go straight to the simulations. If the students miss any of the questions on either of the tests, they are shown the question they missed and then are shown a review containing the answers to the questions they missed. After having a chance to reanswer those questions, they are referred to the simulation portion of the program.

Because of the limitations of computer memory, the simulation section of the program is stored in a separate section of the computer disc than the test section. The student is given simple instructions at the end of the test section on how to access the simulation section.

The simulation section consists of a list describing the functions of the five hormones and five simulations. These simulations are shown in a different order each time the program is run. Each simulation is designed to display the action of a particular hormone. Fig. 1 shows the beginning of the insulin simulation.

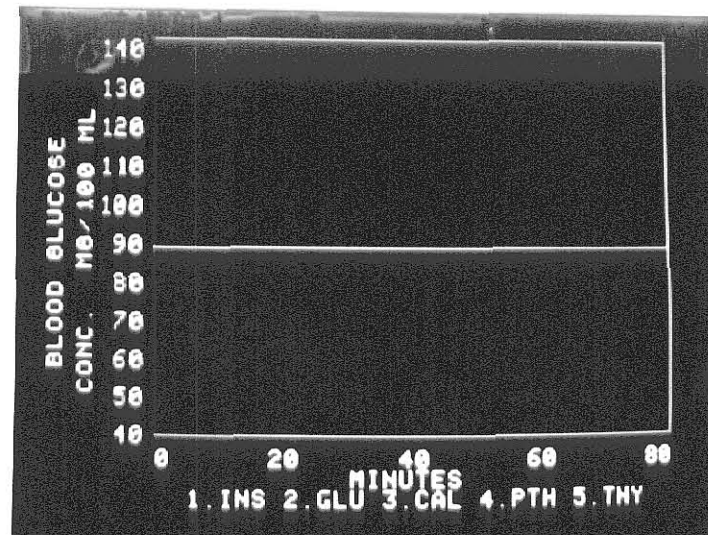


Fig. 1
Computer screen at the beginning of a simulation.

The y axis is labeled with physiological concentrations of blood glucose and the x axis is labeled with time units corresponding to the rate of action of insulin under physiological conditions. The horizontal line running through the middle of the graph is the set level, or optimal physiological level, for blood glucose concentration in humans.

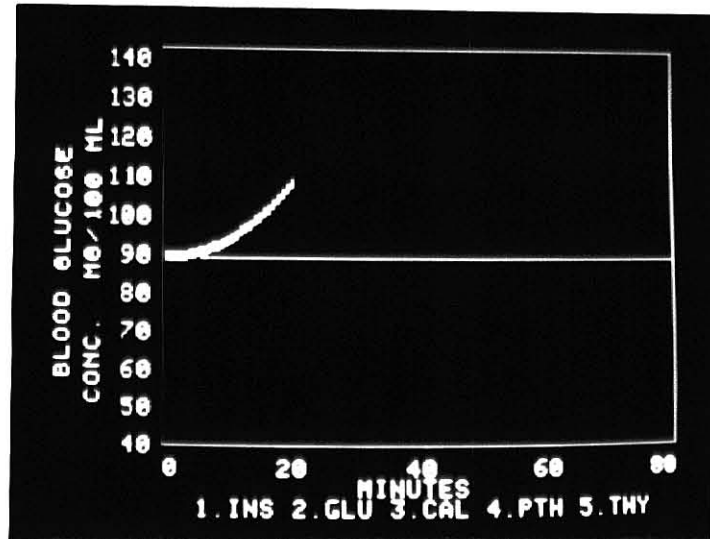


Fig. 2
Computer screen several seconds after
the beginning of a simulation.

The student then sees a rising green line which represents a rising blood glucose concentration (Fig. 2). The student has been instructed to press the number of the hormone (from the list on the bottom of the program) that will return blood glucose concentration to its set level. If he or she gives an incorrect answer or takes too long to give the correct answer, the blood glucose concentration will exceed its normal physiological limits. The line will then turn orange (Fig. 3) and the computer will beep.

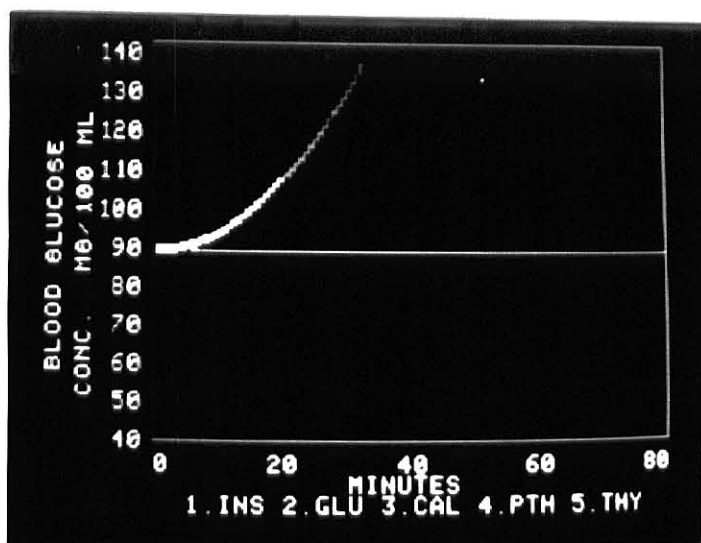


Fig. 3
Computer screen at the end of a simulation in which
the student gave an incorrect answer or no answer.

If the student chooses the correct answer, the curve will return to
the set level, as is seen in Figure 4.

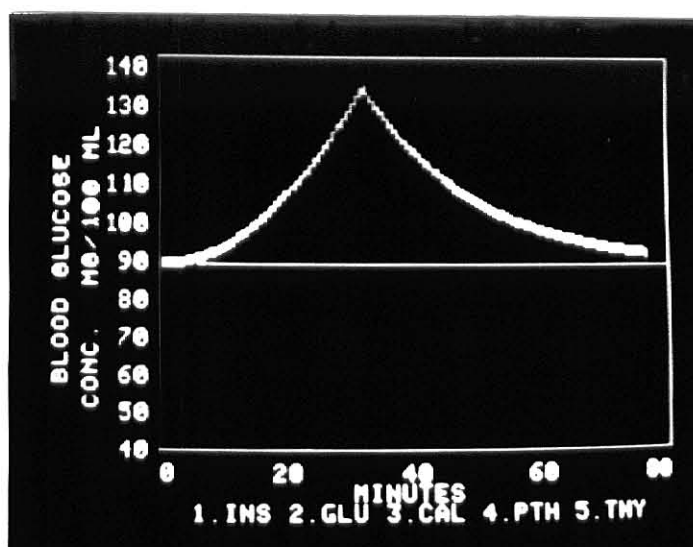


Fig. 4
Computer screen at the end of a simulation in which
the student gave a correct answer.

After each simulation the student has the option of reviewing the hormone list before the next simulation. After viewing all five simulations, the student can view the simulations again by pressing the "1" key or end the program by pressing the "RETURN" key.

V. A Brief Description of Hormones Used in This Program

I selected the five hormones insulin, glucagon, parathyroid hormone, thyroxine and antidiuretic hormone for two reasons. First, they all play prominent roles in homeostasis. Second, their effects are relatively simple and clear-cut, as opposed to hormones such as epinephrine and growth hormone which have many interrelated functions.

My goal was to make the rate of action of each hormone correspond as closely as possible to its rate of action in the normal physiological state. There are several factors that must be taken into consideration when the rate of hormone action is determined. The amount of hormone secreted, the rate of secretion, the effects of antagonistic hormones that oppose a given hormone's activity, the age, sex and health of the subject, as well as various other physiological factors all affect the rate of the expression of a given hormone's activity. Where possible, I tried to use data that related to the hormone's activity in actual physiological conditions, such as a glucose tolerance curve for insulin. For several hormones, though, I was forced to use data which mimicked the normal physiological state.

Insulin

The action of insulin with respect to glucose is threefold: 1) An enhanced rate of glucose metabolism, 2) an increased storage of glucose as glycogen and 3) an increased rate of conversion of glucose to fat. All lead to a decreased blood glucose concentration. Insulin secretion is stimulated by a high blood glucose concentration.

The basis of the insulin curve is the glucose tolerance test, in which a patient drinks a measured amount of glucose (50-100 g) and the

blood glucose level is measured over a three hour period. For normal patients, it takes about an hour for the blood glucose level to fall from an elevated level (140 mg/100 ml) to the set level (85 mg/100 ml).⁷

Glucagon

The effect of glucagon is opposite that of insulin. Glucagon acts to increase the rate of liver glycogenolysis and gluconeogenesis. The ultimate action of glucagon is thus to raise the blood glucose concentration. Glucagon secretion is stimulated by a low blood glucose concentration.

Physiological but high levels of glucagon caused by glucagon infusion cause an extremely rapid release of glucose from the liver (an increase of 100mg/min. over the first ten minutes of infusion).⁸ For a person with an average blood volume (5 liters) this amounts to a rate of change of 2 mg glucose/100 ml/min. This value would only be realistic for a glucose concentration below the set level, where the antagonistic actions of insulin are negligible.⁹

Parathyroid Hormone

Parathyroid hormone, or PTH, has the effect of raising the blood calcium concentration. This rise in blood calcium concentration stems from three effects of PTH: 1) immediate activation of already formed osteoclasts and formation of new osteoclasts. 2) increased reabsorption of calcium from the urine. 3) increased formation of 1,25-dihydroxycholecalciferol from vitamin D, which in turn promotes intestinal absorption of calcium. Another effect of PTH, not seen in this program, is to lower the blood phosphate concentration.

PTH secretion is stimulated by a low blood calcium concentration.

High, but physiological levels of PTH (caused by the infusion of 50 units/day of PTH) cause an increase in blood calcium concentration of 1

mg/100 ml over an eight hour period.¹⁰

Thyroxine

Thyroxine (T_4), along with triiodothyronine (T_3), increases the metabolic rate. The two hormones increase rates of catabolism, glycolysis, gluconeogenesis, and oxygen uptake, and they cause other physiological effects associated with an increased metabolic rate. Thyroxine also acts in conjunction with growth hormone to promote body growth in young people.

I used the basal metabolic rate instead of just the metabolic rate in the thyroxine graph because the metabolic rate constantly changes with activity, emotional state, etc.; the basal metabolic rate more accurately expresses the activity of thyroxine. I chose thyroxine over triiodothyronine because thyroxine supplies roughly two thirds of the total effect of the thyroid hormones on the tissues.¹¹

Injection of 720 g of thyroxine into patients deficient in thyroid hormones causes an increase of the basal metabolic rate of about 2 Kcal/m²/hour over a two day period.¹²

Antidiuretic Hormone

The main action of antidiuretic hormone, or ADH, is to render the collecting ducts of the kidney more permeable to water. This causes more water to leave the collecting ducts for the hypertonic tissue of the inner kidney, causing the kidneys to produce a more concentrated urine at a slower rate. Since ADH retards water loss from the body through the urine, ADH has the effect of lowering the plasma osmolality. ADH secretion is stimulated by a high plasma osmolality.

High but physiological levels of ADH cause a decreased urine output of about 21 ml/hour and an increased osmolality of about 1200 millios-

moles/liter. This means that when ADH concentration is high, the body loses about 63 ml of water/hour (including evaporation, sweat, etc.) and electrolytes are lost at about 30 milliosmoles/hour. Using an average water input (including metabolic water) of about 100 ml/hour, these factors give a drop in plasma osmolality of about 8 milliosmoles/hour over one hour.^{13,14}

VI. Conclusion

The final goal of any educational software is to promote learning. The usefulness of any software is thus determined by how much students learn from it and whether or not the material could be better presented through lecturing or textbook assignments. The best way to obtain this information about effectiveness is to test software in the classroom. Although such testing is not included in this report, it will be essential to the application and further development of "Hormones and Homeostasis".

Although the simulations in "Hormones and Homeostasis" require student input, the input is limited to only one interaction. An improved simulation would allow more student interaction or control over the program. For example, the student could determine the effects of varying amounts of one hormone on another hormone's activity.

Another improvement in the program would be to allow the student to choose the level of difficulty of the simulation. For example, the student could choose the number of different hormones in the simulation and the number of hormones interacting in each part of the simulation. A further refinement of the program would be to allow students to manipulate such factors as environmental temperature and water availability.

Sophisticated simulations such as I have just described would be quite time consuming to produce, yet they make effective and versatile teaching tools. The ability of CAI to simulate real life situations and its capacity to modify its response according to the input from individual students allows CAI to fulfill educational functions which can't be met by the lecturer, the textbook, or the laboratory alone.

"Hormones and Homeostasis" is available on a diskette in the Biology Reading Room, which is located in room 324 of Ackert Hall, Kansas State University.

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Abstract

This report describes an educational computer program entitled "Hormones and Homeostasis." "Hormones and Homeostasis" has two main educational objectives. The first is to teach the concept of homeostasis. The second is to familiarize the student with the functions of five hormones important in homeostasis: insulin, glucagon, parathyroid hormone, thyroxine and antidiuretic hormone. The program is designed for a freshman biology course, but it can be used in an introductory physiology course or an advanced high school biology course.

"Hormones and Homeostasis" consists of a preliminary testing and review section followed by five computer simulations. The simulations consist of graphs showing various physiological factors, such as blood glucose concentration, departing from their set level, or optimum physiological level. If the student chooses the correct hormone, the physiological factor returns to its set level. If the student chooses the wrong hormone, he or she receives an error message. The simulation may be viewed as many times as the student desires.

This report includes a printout of the program itself and specifications for its usage. A brief description of the program is also included along with a description of the data used to design the simulations.

**THIS BOOK WAS
BOUND WITHOUT
PAGE 18.**

**THIS IS AS
RECEIVED FROM
CUSTOMER.**

```
4 REM ***HELLO***  
5 FLASH  
10 HTAB 13: PRINT "LOADING PROGR  
   AM"  
15 NORMAL  
30 PRINT CHR$(4); "RUN HORMONE"
```

```

1000 REM ***HORMONE***
1005 HOME
1010 REM TITLE
1020 VTAB 6: PRINT "-----"
      "-----"

1030 VTAB 8: HTAB 8
1040 PRINT "HORMONES AND HOMEOST
      ASIS:"
1050 HTAB 5: PRINT "AN EDUCATION
      AL COMPUTER PROGRAM"
1060 HTAB 14: PRINT "IN PHYSIOLO
      GY"
1070 VTAB 12: PRINT "-----"
      "-----"

1080 VTAB 23: HTAB 25: PRINT "by
      JACQUES RUPP"
1900 GOSUB 30130
1910 GOSUB 30130
1920 GOSUB 30130
2000 REM PRELIMINARY INSTRUCTIO
      NS
2001 X# = "0"
2003 REM PRTC INSTRUCTIONS
2004 HOME
2005 HTAB 11: PRINT "***INSTRUCT
      IONS***"
2010 VTAB 6
2015 PRINT " YOU are in contro
      l of this program. "
2017 PRINT
2020 PRINT "When you see the sta
      tement PRESS RETURN"
2022 PRINT
2025 PRINT "TO CONTINUE you can
      tell the computer "
2027 PRINT
2030 PRINT "when to go on to the
      next part of the "
2032 PRINT
2035 PRINT "program by pressing
      the RETURN key. "
2037 PRINT
2040 PRINT "This key is located
      on the far right of"
2042 PRINT
2045 PRINT "the keyboard in the
      second or third row"
2047 PRINT
2050 PRINT "from the top. Try p
      ressing this key"

```

```

2052 PRINT
2054 PRINT "now."
2055 GET EX#
2058 REM ACESS TO SIMULATION
2060 IF EX# = "99" THEN GOTO 50
    000
2065 K = ASC (EX#)
2070 IF K = 13 THEN GOTO 2195
2073 HOME
2074 VTAB 6
2075 PRINT "    Sorry, that wasn'
    t the RETURN key."
2077 PRINT
2080 PRINT "The RETURN key is th
    e key with RETURN"
2082 PRINT
2085 PRINT "written on it two or
    three keys down"
2087 PRINT
2090 PRINT "from the top of the
    keyboard; it is"
2092 PRINT
2100 PRINT "on the far right sid
    e of the keyboard."
2103 PRINT
2105 PRINT "Why don't you try ag
    ain?"
2106 GET EX#
2107 K = ASC (EX#)
2110 IF K = 13 THEN GOTO 2195
2113 HOME
2114 VTAB 6
2115 PRINT "    No, that wasn't t
    he RETURN key."
2117 PRINT
2120 PRINT "Why don't you find a
    n instructor to"
2122 PRINT
2125 PRINT "help you? Press the
    RETURN key to go"
2127 PRINT
2130 PRINT "on with the program,
    or press any key"
2132 PRINT
2135 PRINT "on the keyboard stop
    the program."
2140 GET EX#
2145 K = ASC (EX#)
2150 IF K = 13 THEN GOTO 2195
2155 HOME
2160 END
2195 HOME
2200 VTAB 9: HTAB 17: PRINT "PER
    FECT!"

```

```

2202 PRINT : PRINT
2203 HTAB 4: PRINT "Now press th
e RETURN key again."
2210 GOSUB 30000
2305 VTAB 2: PRINT "  HORMONES
AND HOMEOSTASIS contains"
2307 PRINT : PRINT "two sections
. The first section "
2310 PRINT : PRINT "consists of
two tests- one on hormones"
2312 PRINT : PRINT "and the othe
r on homeostasis. In the"
2315 PRINT : PRINT "last section
you use the knowledge you"
2317 PRINT : PRINT "were tested
on in a series of"
2320 PRINT : PRINT "biological c
omputer simulations."
2322 PRINT : PRINT " Each test
consists of four multiple"
2325 PRINT : PRINT "choice quest
ions."
2348 GOSUB 30000
2349 VTAB 2
2350 PRINT " Choose the best a
nswer to each"
2352 PRINT
2355 PRINT "question. Then pres
s the key in the"
2357 PRINT
2360 PRINT "top row of the keybo
ard which has the"
2362 PRINT
2365 PRINT "number of the answer
you chose on it."
2367 PRINT : PRINT "Do not press
the number of your answer"
2368 PRINT : PRINT "more than on
ce because it will be"
2369 PRINT : PRINT "counted as t
he answer to the following"
2370 PRINT : PRINT "question."
2375 GOSUB 30000
2380 VTAB 6
2385 PRINT " Following the pre
viously described"
2390 PRINT "procedure, try anser
ing this practice"
2395 PRINT "question:"
2400 PRINT : PRINT : PRINT
2405 PRINT "The fluid which carr
ies oxygen and"
2407 PRINT "nutrients to the bod
y is called:"

```

```

2409 PRINT : PRINT
2411 HTAB 10: PRINT "1. Lymph"
2413 HTAB 10: PRINT "2. Bile"
2415 HTAB 10: PRINT "3. Blood"
2417 HTAB 10: PRINT "4. Gastric
      juice"
2420 GET SA#
2422 HOME
2424 GOSUB 40000
2450 REM INTRO TO TESTS
2455 VTAB 2
2460 PRINT "    If you answer all
      the questions"
2465 PRINT
2470 PRINT "correctly on these t
      wo tests, you will"
2475 PRINT
2480 PRINT "immediately go on to
      the biological"
2482 PRINT
2485 PRINT "simulations.  If you
      miss any of the"
2488 PRINT
2490 PRINT "questions on one or
      both of the tests"
2495 PRINT
2500 PRINT "you will be given a
      short review on the"
2505 PRINT
2510 PRINT "topic of that test a
      nd you will be"
2515 PRINT
2520 PRINT "given another chance
      to answer the"
2525 PRINT
2530 PRINT "questions you missed
      correctly.  You"
2535 PRINT
2540 PRINT "can then proceed to
      the next part of "
2545 PRINT
2550 PRINT "the program."
2555 REM PRIC
2560 GOSUB 30000
2565 REM HORMONE TEST
2570 VTAB 7: HTAB 14
2575 PRINT "HORMONE TEST"
2580 VTAB 6: HTAB 14: PRINT "***
      *****"
2585 VTAB 8: HTAB 14: PRINT "***
      *****"
2590 GOSUB 30130
2595 HOME
2597 REM READ DATA INTO ARRAY

```



```

2598 GOSUB 30200
2599 GOSUB 32500
2600 HOME
2601 IF W > 0 THEN GOTO 2650
2605 VTAB 6: PRINT "    Great!  Y
      ou scored 4 out of 4 on the"

2606 PRINT "first try!  Now try
      the homeostasis"
2607 PRINT "test."
2610 GOSUB 30000
2615 GOTO 4000
2650 IF W > 2 THEN GOTO 2800
2652 REM 1 OR 2 MISSED
2655 REM PRINT QUESTIONS MISSED

2660 HOME
2662 GOSUB 42000
2664 VTAB 2
2665 PRINT "    You will now see
      a brief review on"
2666 PRINT
2667 PRINT "hormones.  The answe
      rs to all of the"
2668 PRINT
2669 PRINT "test questions will
      be highlighted in"
2670 PRINT
2671 PRINT "the following fashio
      n: ";
2672 INVERSE
2673 PRINT "HORMONE";
2674 NORMAL
2675 PRINT ".  Read": PRINT "": PRINT
      "over the review, paying pat
      icular"
2676 PRINT "": PRINT "attention
      to the answers to the"
2677 PRINT "": PRINT "questions
      you missed.  You will then b
      e": PRINT "": PRINT "tested
      again on those questions."
2678 GOSUB 30000
2679 GOTO 3000
2800 REM 3 OR 4 MISSED
2805 REM PRINT QUESTIONS MISSED

2810 GOSUB 42000
2813 VTAB 6
2815 PRINT "    You may wish to s
      top the program and"
2817 PRINT "": PRINT "review hor
      mones in your textbook at"
2819 PRINT "": PRINT "this point

```

```

      .  If so, press the key"
2821  PRINT "": PRINT "marked 1.
      If you wish to continue,"
2823  PRINT "": PRINT "press RETU
      RN."
2825  GET X#
2835  HOME
2836  IF X# < > "1" THEN GOTO 2
      664
2840  END
3000  GOSUB 33000
3200  REM REANSWER QUESTIONS MIS
      SED, EVALUATE, STORE
3205  GOSUB 42100
3207  HOME
3210  REM BRANCH TO POS FEEDBACK

3215  IF W = 0 THEN GOTO 3900
3220  REM PRINT QUESTIONS MISSED
      AND ANSWERS
3225  GOSUB 42500
3226  VTAB 6
3228  PRINT " Now press the RET
      URN key to take the"
3229  PRINT "": PRINT "homeostasi
      s test."
3230  REM PRTC
3235  GOSUB 30000
3240  GOTO 4000
3900  REM ALL CORRECT
3905  VTAB 6: PRINT " Good! Yo
      u answered all the"
3907  PRINT "": PRINT "questions
      correctly. Now take the "
3909  PRINT "": PRINT "homeostasi
      s test."
3910  REM PRTC
3915  GOSUB 30000
4000  REM HOMEOSTASIS TEST
4005  REM TITLE
4007  HOME
4010  VTAB 6: HTAB 12: PRINT "***
      *****"
4015  VTAB 7: HTAB 12: PRINT "HOM
      EOSTASIS TEST"
4020  VTAB 8: HTAB 12: PRINT "***
      *****"
4025  REM PRTC
4030  GOSUB 30130
4035  REM TEST
4036  REM LOAD DATA
4037  GOSUB 30200
4039  REM RESET W
4040  W = 0

```

```

4045 GOSUB 32500
4050 IF W > 0 GOTO 4105
4052 HOME
4055 VTAB 6: PRINT "    Fantastic
!    You scored 4 out of 4!"
4060 PRINT "": PRINT "Now go on
to the final part of this"
4065 PRINT "": PRINT "program."
4067 REM PRTC
4069 GOSUB 30000
4070 GOTO 50000
4105 REM 1 OR 2 MISSED
4110 REM PRINT QUESTIONS MISSED

4115 HOME
4117 GOSUB 42000
4119 VTAB 2
4120 PRINT "    You will now see
a brief review on"
4125 PRINT "": PRINT "homeostasi
s. The answers to all the"
4130 PRINT "": PRINT "questions
will be highlighted in the "

4132 PRINT
4135 PRINT "following fashion: "
;
4140 INVERSE
4145 PRINT "HOMEOSTASIS";
4150 NORMAL
4155 PRINT ". Read"
4160 PRINT "": PRINT "over the r
eview, paying particular"
4165 PRINT "": PRINT "attention
to the answers to the"
4170 PRINT "": PRINT "questions
you missed. You will then b
e"
4175 PRINT "": PRINT "tested aga
in on those questions."
4200 GOSUB 30000
4210 GOTO 5000
5000 REM HOMEOSTASIS REVIEW
5005 GOSUB 34000
5210 REM REANSWER QUESTIONS MIS
SED
5215 GOSUB 42100
5218 HOME
5220 REM PDS FEEDBACK
5225 IF W = 0 THEN GOTO 49900
5230 REM PRINT QUESTIONS MISSED

5235 GOSUB 42500
5240 PRINT

```

```

5241 PRINT
5242 PRINT "    Now press the RETURN key to go on to"
5245 PRINT "the final portion of this program."
5250 REM FRTC
5252 GOSUB 30000
5260 GOTO 50000
30000 REM PRESS RETURN TO CONTINUE
30005 VTAB 24: HTAB 8
30010 INVERSE
30015 PRINT "PRESS RETURN TO CONTINUE"
30020 NORMAL
30025 GET DD#
30026 K1 = ASC (DD#)
30027 IF K1 = 13 THEN GOTO 30030
30028 GOTO 30025
30030 HOME
30035 RETURN
30130 REM 5 SECOND PAUSE
30135 FOR T = 1 TO 3000
30140 NEXT T
30145 RETURN
30200 REM READ DATA INTO ARRAY
30205 FOR I = 1 TO 4
30210 FOR J = 1 TO 6
30215 READ D$(I,J)
30220 NEXT J
30225 NEXT I
30230 RETURN
30235 REM DATA
30240 DATA "Typically, a hormone is an organic molecule that is secreted from a tissue of an organism and that:"
30245 DATA "Regulates the tissue from which it was secreted."
30250 DATA "Regulates similar tissues or organs of other organisms."
30255 DATA "Regulates all tissues of an organism."
30260 DATA "Regulates some other tissues or organs of the organism."
30265 DATA 4
30270 DATA "Hormones are transported by the:"
30275 DATA "Lymphatic system."

```

30280 DATA "Nervous system.," "Respiratory system.," "Circulatory system.," 4

30285 DATA "The action of hormones is best described by which of the following sets of terms:"

30290 DATA "Non-specific, all tissues", "Highly specific, target tissues"

30295 DATA "Non-specific, target tissues", "Highly specific, all tissues"

30298 DATA 2

30300 DATA "Compared to the nervous system, hormones act at:"

30305 DATA "A much more rapid rate.," "A slower rate.," "About the same rate.," "A more rapid rate."

30307 DATA 2

30310 REM HOMEOSTASIS TEST

30315 DATA "Homeostasis is:"

30320 DATA "Maintenance of relatively constant conditions within the body."

30325 DATA "Periodic fluctuation of conditions within the body."

30330 DATA "Random fluctuation of conditions within the body."

30335 DATA "Rapid deterioration of conditions within the body."

30340 DATA 1, "The molecular structures and chemical reactions of the human body function effectively:"

30345 DATA "In a wide range of temperature, pH, and chemical concentrations."

30350 DATA "Only within a narrow range of temperature, but in a wide range of pH and chemical concentrations."

30355 DATA "Only within a narrow range of pH, but in a wide range of temperature and chemical concentrations."

30360 DATA "Only within a narrow range of temperature, pH, and chemical concentrations"

```

ns.",4
30365 DATA "Which of the follow
ing sets would make the bes
t model to illustrate
homeostasis?"
30370 DATA "Faucet, water pipes
, water flow."
30375 DATA "Light switch, light
bulb, light."
30377 DATA "Thermostat, furnace
, room temperature."
30380 DATA "Dial, radio, statio
n selection.", 3
30385 DATA "When the blood gluc
ose concentration falls b
elow a specific set level, t
he hormone glucagon is rel
eased. Which of the followi
ng would most likely be the
effect of glucagon?"
30390 DATA "All available gluco
se in the liver is relea
sed into the blood."
30395 DATA "Glucose is released
from the liver into the
blood until the blood gl
ucose concentration returns
to its setlevel."
30400 DATA "Glucose is released
from the liver into the
blood until the blood is sa
turated with glucose."
30405 DATA "Insignificant amoun
ts of glucose are released i
nto the blood.",2
32500 REM TEST
32515 FOR I = 1 TO 4
32520 HOME
32525 VTAB 6
32530 REM PRINT QUESTION
32535 PRINT Q$(I,1)
32540 PRINT : PRINT
32545 REM PRINT NUMBERED CHOICE
5
32550 FOR J = 2 TO 5
32555 HTAB 5
32560 PRINT J - 1". "; PRINT Q$(
(I,J)
32562 PRINT
32565 NEXT J
32570 PRINT
32575 REM INPUT STUDENT ANSWER
32580 GET SA#
32585 REM EVALUATE TEST, STORE

```

QUESTIONS MISSED

```

32590 GOSUB 40200
32595 NEXT I
32598 RETURN
33000 REM HORMONE
33005 VTAB 3
33010 HTAB 10: PRINT "***HORMONE
      REVIEW***"
33015 PRINT : PRINT : PRINT
33020 PRINT "  A hormone is an
      organic molecule"
33022 PRINT
33025 PRINT "that is secreted, u
      sually in minute"
33027 PRINT
33030 PRINT "amounts, from one t
      issue of an organism"
33035 PRINT
33040 PRINT "and that ";
33048 INVERSE
33049 PRINT "REGULATES";
33050 NORMAL
33055 PRINT " the function of";
33057 PRINT " ";
33060 INVERSE
33065 PRINT "OTHER"
33070 PRINT "TISSUES OR ORGANS";

33075 NORMAL
33080 PRINT " ";
33090 PRINT "of the organism."
33100 PRINT
33105 PRINT "Hormones are secret
      ed by glands into"
33110 PRINT
33112 PRINT "the";
33113 PRINT " ";
33114 INVERSE
33116 PRINT "CIRCULATORY SYSTEM"
      ;
33117 NORMAL
33118 PRINT " and are carried"
33120 PRINT
33125 PRINT "by the blood throug
      hout the body."
33130 PRINT
33132 GOSUB 30000
33140 VTAB 2
33145 PRINT "  Hormones exert o
      ne or more";
33148 PRINT " ";
33150 INVERSE
33155 PRINT "HIGHLY"
33157 PRINT

```

```

33160 PRINT "SPECIFIC EFFECTS";
33165 NORMAL
33170 PRINT " on their ";
33175 INVERSE
33180 PRINT "TARGET TISSUE";
33185 NORMAL
33190 PRINT
33195 PRINT
33200 PRINT "or tissues. For ex
      ample, prolactin, a "
33205 PRINT
33210 PRINT "hormone secreted by
      the anterior"
33212 PRINT
33215 PRINT "pituitary, stimulat
      es milk secretion"
33217 PRINT
33220 PRINT "in breast tissues.
      These effects,"
33222 PRINT
33225 PRINT "however, occur ";
33230 INVERSE
33235 PRINT "MORE SLOWLY";
33240 NORMAL
33242 PRINT " ";
33245 PRINT "than those";
33248 PRINT
33250 PRINT
33255 PRINT "elicited by the ";
33260 INVERSE
33265 PRINT "NERVOUS SYSTEM";
33270 NORMAL
33275 PRINT " ."
33280 PRINT
33282 GOSUB 30000
33283 VTAB 2
33285 PRINT " Some hormones ar
      e concerned with"
33287 PRINT
33290 PRINT "change- either the
      changes associated"
33295 PRINT
33300 PRINT "with maturation or
      in response to"
33302 PRINT
33305 PRINT "external events. H
      ormones are also"
33310 PRINT
33315 PRINT "involved in homeost
      atic regulation. "
33317 PRINT
33320 PRINT "The latter hormones
      are the subject of"
33322 PRINT

```



```

33325 PRINT "this program."
33500 GOSUB 30000
33505 RETURN
34000 VTAB 3
34005 HTAB 8: PRINT "***HOMEOSTA
      SIS REVIEW***"
34010 PRINT : PRINT : PRINT
34015 PRINT "    Homeostasis is "
      ;
34020 INVERSE
34025 PRINT "MAINTENANCE OF"
34030 PRINT
34035 PRINT "RELATIVELY CONSTANT
      CONDITIONS";
34040 NORMAL
34042 PRINT " ";
34045 PRINT "within"
34050 PRINT
34055 PRINT "the body. The mole
      cular structures and"
34060 PRINT
34065 PRINT "chemical reactions
      of the human body"
34067 PRINT
34070 PRINT "function well only
      within ";
34075 INVERSE
34080 PRINT "NARROW LIMITS"
34085 PRINT
34090 PRINT "OF TEMPERATURE AND
      PH";
34095 NORMAL
34100 PRINT ", and ";
34101 INVERSE
34102 PRINT "CHEMICALS"
34103 NORMAL
34105 PRINT
34110 PRINT "needed by the body
      can be lethal except"
34115 PRINT
34117 INVERSE
34120 PRINT "WITHIN NARROW LIMIT
      S OF CONCENTRATION."
34122 NORMAL
34125 GOSUB 30000
34127 VTAB 2
34130 PRINT "Thus the tissues an
      d organs of the body"
34135 PRINT
34140 PRINT "are continually act
      ing to keep"
34145 PRINT
34150 PRINT "properties of the b
      ody's internal"

```

```

34152 PRINT
34155 PRINT "environment such as
        temperature and"
34160 PRINT
34165 PRINT "the concentration o
        f nutrients, gases,"
34170 PRINT
34175 PRINT "ions, and water at
        a set level which is"
34180 PRINT
34185 PRINT "favorable to the fu
        nctioning of the"
34190 PRINT
34195 PRINT "cells."
34200 GOSUB 30000
34202 VTAB 2
34205 PRINT "    The process of h
        omeostasis can be"
34210 PRINT
34215 PRINT "compared to the act
        ion of a ";
34216 INVERSE
34217 PRINT "THERMOSTAT"
34220 PRINT
34225 PRINT "AND FURNACE CONTROL
        LING ROOM"
34230 PRINT
34235 PRINT "TEMPERATURE";
34236 NORMAL
34237 PRINT ".    The set level fo
        r the"
34240 PRINT
34245 PRINT "temperature of the
        room is determined"
34250 PRINT
34255 PRINT "by the position at
        which the thermostat"
34257 PRINT
34260 PRINT "is set.    If the tem
        perature falls below"
34265 PRINT
34270 PRINT "the set level the t
        hermostat senses"
34275 PRINT
34280 PRINT "this and sends a si
        gnal (electrical"
34285 PRINT
34290 PRINT "current) to a furna
        ce which raises the"
34295 PRINT
34300 PRINT "room temperature."
34305 GOSUB 30000
34307 VTAB 2
34310 PRINT "    When the tempera

```

```

    ture reaches the set"
34315 PRINT
34320 PRINT "level, the heat tur
    ns off the control"
34325 PRINT
34330 PRINT "signal from the the
    rmostat and the"
34335 PRINT
34340 PRINT "furnace turns off.
    Thus the room "
34342 PRINT
34345 PRINT "temperature is main
    tained at the set"
34347 PRINT
34350 PRINT "level."
34355 PRINT
34360 PRINT "    In a similar fas
    hion, the body "
34365 PRINT
34370 PRINT "maintains relativel
    y constant"
34375 PRINT
34380 PRINT "internal conditions
    by continually"
34385 PRINT
34390 PRINT "monitoring the inte
    rnal environment and"
34395 PRINT
34400 PRINT "comparing it to set
    values."
34405 GOSUB 30000
34407 VTAB 2
34410 PRINT "    If any characteri
    stic of the internal"
34412 PRINT
34415 PRINT "environment deviate
    s from its set level"
34420 PRINT
34425 PRINT "certain organs or t
    issues of the body"
34427 PRINT
34430 PRINT "produce a specific
    signal, which can be"
34435 PRINT
34440 PRINT "either hormonal or
    nervous. This"
34445 PRINT
34450 PRINT "signal causes the a
    ppropriate"
34455 PRINT
34460 PRINT "mechanisms of the b
    ody to work hard to"
34465 PRINT
34470 PRINT "return the internal

```

```

environment to its"
34472 PRINT
34475 PRINT "set level."
34480 GOSUB 30000
34485 VTAB 2
34490 PRINT "    The regulation o
f blood glucose"
34495 PRINT
34500 PRINT "concentration is an
example of"
34505 PRINT
34510 PRINT "homeostasis. If bl
ood glucose levels"
34515 PRINT
34520 PRINT "rise above the set
level, specialized"
34525 PRINT
34530 PRINT "cells in the pancre
as sense this and"
34532 PRINT
34535 PRINT "produce the hormone
insulin. Insulin "
34540 PRINT
34545 PRINT "acts on the cells o
f the body, causing"
34550 PRINT
34555 PRINT "an accelerated tran
sport of glucose"
34560 PRINT
34565 PRINT "from the blood into
cells until the "
34570 PRINT
34575 PRINT "concentration of gl
ucose falls to the"
34580 PRINT
34585 PRINT "set level."
34590 GOSUB 30000
34595 VTAB 2
34600 PRINT "    If the glucose c
oncentration ";
34605 INVERSE
34610 PRINT "FALLS"
34615 PRINT
34620 PRINT "BELOW THE SET LEVEL
";
34625 NORMAL
34630 PRINT ", the body produces
"
34632 PRINT
34635 PRINT "the hormone ";
34640 INVERSE
34645 PRINT "GLUCAGON";
34650 NORMAL
34655 PRINT ", which causes"

```

```

34657 PRINT
34660 PRINT "the ";
34665 INVERSE
34670 PRINT "RELEASE OF GLUCOSE
      FROM THE LIVER";
34675 NORMAL
34680 PRINT " ."
34685 PRINT
34690 PRINT "The glucose concent
      ration";
34692 PRINT " ";
34700 INVERSE
34705 PRINT "RISES UNTIL IT";
34710 PRINT
34715 PRINT "REACHES THE SET LEV
      EL";
34720 NORMAL
34725 PRINT " ."
34730 PRINT
34735 PRINT "    The final portio
      n of this program"
34740 PRINT
34745 PRINT "demonstrates how fi
      ve hormones,"
34747 PRINT
34750 PRINT "including insulin a
      nd glucagon,"
34752 PRINT
34755 PRINT "function in homeost
      asis."
34760 GOSUB 30000
34765 RETURN
35000 STOP
40000 REM PRACTICE TEST EVALUAT
      ION
40010 IF SA4 < > "3" THEN GOTO
      40100
40015 VTAB 6
40016 PRINT "    Excellent! You d
      id that perfectly."
40017 PRINT "Now go on to the ho
      rmone and homeostasistests."

40090 GOSUB 30000
40095 RETURN
40100 VTAB 6
40105 PRINT "    The correct answ
      er is 3; blood"
40107 PRINT
40110 PRINT "carries oxygen and
      nutrients to the"
40112 PRINT
40115 PRINT "tissues of the body
      . You may wish to"

```

```

40117 PRINT
40120 PRINT "stop the program an
      d review physiology"
40125 PRINT
40130 PRINT "in your textbook at
      this point.  If so,"
40135 PRINT
40140 PRINT "press the key in to
      p row of the"
40145 PRINT
40147 PRINT "keyboard marked 1.
      If you wish to take"
40149 PRINT
40150 PRINT "the hormone test pr
      ess the RETURN key."
40155 GET X$
40157 HOME
40160 IF X$ = "1" THEN END
40165 RETURN
40170 HOME
40175 END
40200 REM TEST EVALUATION, STOR
      E QUESTIONS MISSED
40205 IF SA4 = 0$(1,6) THEN GOTO
      40400
40210 W = W + 1
40215 R$(W,1) = 0$(1,1)
40220 R$(W,2) = 0$(1,2)
40225 R$(W,3) = 0$(1,3)
40230 R$(W,4) = 0$(1,4)
40235 R$(W,5) = 0$(1,5)
40240 R$(W,6) = 0$(1,6)
40400 RETURN
42000 REM PRINT QUESTIONS MISSE
      D
42004 VTAB 6
42005 PRINT "You missed the foll
      owing question(s):"
42006 GOSUB 30130
42007 HOME
42010 PRINT : PRINT : PRINT
42015 FOR K = 1 TO W
42017 VTAB 6
42020 PRINT R$(K,1): PRINT : PRINT

42022 GOSUB 30000
42025 NEXT K
42035 RETURN
42100 REM REANSWER QUESTIONS MI
      SSED
42102 HOME
42103 VTAB 6
42105 PRINT "Now try the questio
      n(s) you missed"

```

```

42107 PRINT "again:"
42110 REM PAUSE
42115 GOSUB 30130
42120 HOME
42125 REM PRINT QUESTIONS
42126 W = W
42128 W = 0
42130 FOR I = 1 TO W1
42135 HOME
42140 VTAB 6
42145 REM PRINT QUESTION
42150 PRINT R$(I,1)
42155 PRINT : PRINT
42160 REM PRINT NUMBERED CHOICE
S
42165 FOR J = 2 TO 5
42170 HTAB 5
42175 PRINT J - 1; ". ": PRINT R
$(I,J)
42178 NEXT J
42180 PRINT
42185 REM INPUT ANSWER
42190 GET SA$
42195 REM EVALUATE ANSWER, FLAG
QUESTIONS MISSED
42198 IF SA$ = R$(I,6) THEN GOTO
42205
42200 R$(I,7) = "WR"
42202 W = W + 1
42205 NEXT I
42210 RETURN
42500 REM PRINT QUESTIONS MISSE
D AND THEIR ANSWERS
42504 VTAB 2
42505 PRINT "Here are the questi
on(s) you missed and"
42506 PRINT "their answers:"
42510 PRINT : PRINT
42515 FOR I = 1 TO W1
42517 IF R$(I,7) < > "WR" GOTO
42545
42518 VTAB 6
42520 PRINT R$(I,1)
42530 R = VAL (R$(I,6)) + 1
42532 PRINT : PRINT
42535 PRINT "ANSWER: "; R$(I,R)
42540 GOSUB 30000
42545 NEXT I
42550 RETURN
49900 REM ALL CORRECT
49905 VTAB 6: PRINT " Great!
You have correctly answered
"
49906 PRINT "": PRINT "all the q

```

```

      uestions.  Now press RETURN
      to"
49908  PRINT "": PRINT "the final
      part of the program."
49910  REM  PRTO
49915  GOSUB 30000
49920  GOTO 50000
50000  REM  INTRO SIMULATION
50005  VTAB 2
50010  HTAB 5: PRINT "***SIMULATI
      ON INSTRUCTIONS***"
50020  VTAB 6: PRINT "    In the f
      ollowing simulations, you"
50030  PRINT : PRINT "will see so
      me physiological factor in "

50040  PRINT : PRINT "a certain p
      atient X depart from its set
      "
50050  PRINT : PRINT "level.  For
      example, his blood glucose"

50060  PRINT : PRINT "concentrati
      on could rise abnormally"
50070  PRINT : PRINT "high, as oc
      curs in untreated diabetes."

50075  GOSUB 30000
50080  PRINT : PRINT "    Your jo
      b, as patient X's hormonal"
50090  PRINT : PRINT "system, is
      to secrete the correct"
50100  PRINT : PRINT "hormone to
      bring the physiological"
50110  PRINT : PRINT "factor back
      to its set level.  This "
50120  PRINT : PRINT "process of
      maintaining physiological"
50130  PRINT : PRINT "conditions
      at their set levels is"
50140  PRINT : PRINT "homeostasis
      ."
50150  GOSUB 30000
50160  PRINT : PRINT "    Each sim
      ulation consists of a graph"

50170  PRINT : PRINT "whose verti
      cle axis is labeled with the
      "
50180  PRINT : PRINT "physiologic
      al condition being affected-
      "
50190  PRINT : PRINT "for example
      , blood glucose"

```



```

50200 PRINT : PRINT "concentrati
      on- while the horizontal"
50210 PRINT : PRINT "axis is lab
      eled with the time over"
50220 PRINT : PRINT "which the c
      hange occurs. A horizontal"

50230 PRINT : PRINT "line runnin
      g through the center of the
      "
50240 PRINT : PRINT "graph repre
      sents the set level for"
50250 PRINT : PRINT "that condit
      ion."
50260 GOSUB 30000
50270 PRINT : PRINT " You will
      see a line curving either"
50280 PRINT : PRINT "up or down.
      This represents the"
50290 PRINT : PRINT "physiologic
      al factor departing from the
      "
50300 PRINT : PRINT "set level.
      If the physiological factor
      "
50310 PRINT : PRINT "exceeds its
      normal biological range,"
50320 PRINT : PRINT "the line wi
      ll turn orange (if you have"

50330 PRINT : PRINT "a color scr
      een) and the computer will"
50340 PRINT : PRINT "beep."
50350 GOSUB 30000
50360 PRINT : PRINT " At the b
      eginning of the simulations"

50365 PRINT
50370 PRINT "you will see a list
      of five hormones"
50375 PRINT
50380 PRINT "and their actions.
      Familiarize"
50385 PRINT
50390 PRINT "yourself with this
      list. At the bottom"
50395 PRINT
50400 PRINT "of each simulation
      you will see three "
50405 PRINT
50410 PRINT "letter abbreviation
      s of the hormones on"
50420 PRINT : PRINT "the list nu
      mbered one through five."

```

```
50430 GOSUB 30000
50435 VTAB 2
50440 PRINT "    Press the key of
        the number of the "
50450 PRINT : PRINT "hormone who
        se action will return the"
50460 PRINT : PRINT "physiologic
        al factor to its set level."

50470 PRINT : PRINT "You will on
        ly have one chance, so chose
        "
50480 PRINT : PRINT "the correct
        hormone the first time!"
50490 GOSUB 30000
50500 PRINT "    To begin the sim
        ulations you must"
50510 PRINT : PRINT "follow thes
        e steps.  If there is a key"

50515 PRINT
50520 PRINT "marked 'CAPS LOCK'
        in the lower left"
50525 PRINT
50530 PRINT "hand corner of the
        keyboard, make sure"
50535 PRINT
50540 PRINT "it is in the depres
        sed position.  Then"
50545 PRINT
50550 PRINT "type the following
        words just as they"
50555 PRINT
50560 PRINT "they are written an
        d then press the "
50565 PRINT
50570 PRINT "RETURN key:"
50575 PRINT
50580 PRINT "RUN PHYSIM"
50590 PRINT : PRINT "    If you g
        et an error message, check"
50600 PRINT : PRINT "the CAPS LO
        CK key and try again."
50620 END
```

**THE FOLLOWING
PAGE IS CUT OFF**

**THIS IS AS
RECEIVED FROM
THE CUSTOMER**

```
5  REN  ***PHYSIM***
10  POKL 103,1
20  POKL 104,64
30  POKL 16384,0
35  PRINT CH# (4) "BLOAD ALPHA"
40  PRINT CH# (4); "RUN LINEGRAP
    H 2"
```

```

6  REM ***LINEGRAPH 2***
8  HOME
9  GOSUB 17000
10 J = 0
15 RH = 0
20 FOR J = 1 TO 5
30 C(J) = INT (5 * RND (1)) + 1

40 IF J < 2 THEN GOTO 90
50 FOR A1 = J TO 1 STEP - 1
60 IF C(J) = C(A1 - 1) THEN GOTO
   30
70 NEXT A1
90 FOR A2 = 1 TO C(J)
100 READ Z1$,Z2$,VT,1,D,E,L
110 NEXT A2
115 RESTORE
120 DATA "BLOOD GLUCOSE","CONC
   . MG/100 ML",140,10,108,.97
   ,
   30
130 DATA "BLOOD GLUCOSE","CON
   C. MG/100 ML",140,10, -10
   B
   ,
   .9
   4,30
140 DATA "BLOOD OSMOLALITY","MI
   LLIOSMOLS/LITER", 325,5,108,
   .97,30
150 DATA "BLOOD CALCIUM","CON
   C. ME/100 ML",15,1,-108,.94
   ,
   15
160 DATA "BASAL METABOLIC RATE
   ", "KCAL/M SQUAR
   ED/HR",51,2,-108,.99,20
170 DATA "BLOOD OSMOLALITY","MI
   LLIMOLS/LITER",325,5,108,.94
   ,30
175 AN = 0
177 RH = 0
180 GOSUB 2000
200 NEXT J
210 HOME
220 VTAB 8: PRINT " If you wis
   h to see the simulations a
   gain, press 1. If you wish
   to end the program, press RE
   TURN."
240 GET TA$
250 TA = VAL (TA$)
255 HOME
260 IF TA = 1 THEN GOTO 4
265 VTAB 8
270 PRINT " I hope you enjoyed
   HORMONES AND HOMEOSTAS

```

```

15. Please turn off the
    computer's power switch b
efore you leave."
280 END
2000 PRINT CHR$(4)"BLOAD ALPHA
"
2020 HGR : HCOLOR= 6
2030 HPLLOT 48,0 TO 48,154 TO 278
    ,154 TO 278,0 TO 48,0
2040 HPLLOT 48,80 TO 278,80
2220 DZ$ = "U"
2230 RZ = 48
2240 ZZ$ = Z1$
2250 LZ = LEN (ZZ$)
2260 ZX = 3
2270 ZY = 7 * LZ + .5 * (159 - 7 *
    LZ)
2280 GOSUB 6000
2290 ZZ$ = Z2$
2300 LZ = LEN (ZZ$)
2310 ZX = 17
2320 ZY = 7 * LZ + .5 * (159 - 7 *
    LZ)
2330 GOSUB 6000
2340 RZ = 0
2345 DZ$ = "R"
2350 FOR A3 = 0 TO 10
2360 ZZ = VT - A3 * I
2370 ZZ$ = STR$(ZZ)
2380 LZ = LEN (ZZ$)
2390 ZX = 47 - 7 * LZ
2400 ZY = 15 * A3 + 4
2410 GOSUB 6000
2420 NEXT A3
2430 CH = 0
2450 GOSUB 13000
2510 HCOLOR= 1
2520 FOR X = 50 TO 277
2540 GOSUB 7000
2542 IF RH = 0 THEN GOTO 2545
2543 RETURN
2545 IF AN = 1 THEN GOTO 11070
2550 Y = B2 - ((X - 50) ^ 2 / D)
2560 IF Y < B2 - L OR Y > B2 + L
    THEN GOSUB 8000
2570 HPLLOT X,Y TO X,Y - 3
2580 IF Y < 5 OR Y > 149 THEN GOTO
    10000
2590 NEXT X
2600 XR = X
2620 YR = Y
2630 FOR X = XR TO 275
2640 Y = B2 - ((B2 - YR) * E ^ (X
    - XR))

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2650 IF Y < B2 - L OR Y > B2 + L
    THEN GOTO 2680
2660 HCOLOR= 1
2670 GOTO 2690
2680 GOSUB 8000
2690 HPLOT X,Y TO X,Y + 3
2700 NEXT X
2710 AN = 1
2720 GOTO 10000
6000 REM DRAW CHARACTERS- MODIF
    IED FROM A PROGRAM BY M.L. M
    ITCHELL
6020 POKE 232,5000 - INT (5000 /
    256) * 256
6025 POKE 233, INT (5000 / 256)
6030 HCOLOR= 3
6035 ROT= RZ
6040 IF DZ$ = "R" THEN I$ = 7
6050 IF DZ$ = "U" THEN I$ = - 7

6060 XZ = ZX:YZ = ZY
6070 SCALE= 1
6080 FOR A = 1 TO LZ
6090 Z9$ = MID$ (ZZ$,A,1)
6100 ZN = ASC (Z9$) - 31
6110 XDRAW ZN AT XZ,YZ
6120 IF I$ = 7 THEN XZ = XZ + I$
    : GOTO 6140
6130 YZ = YZ + I$
6140 NEXT A
6150 RETURN
7000 P = PEEK (49152)
7020 IF P < 128 THEN GOTO 7070
7030 CH = CH + 1
7040 P$ = CHR$ (P - 128): POKE 4
    9168,0
7050 PA = VAL (P$)
7060 IF PA = C(0) AND CH = 1 THEN
    GOTO 2600
7070 RETURN
8000 REM ABOVE LEVEL
8010 HCOLOR= 5
8020 B = B + 1
8030 IF B < > 5 THEN GOTO 8050

8035 VTAB 10: PRINT CHR$ (7)
8040 B = 0
8050 RETURN
10000 TEXT
10005 HOME
10010 VTAB 8: HTAB 17
10020 IF AN = 0 THEN PRINT "WRD
    NG!"
10030 IF AN = 1 THEN PRINT "RIG

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      HT!"
11000 VTAB 14
11010 IF C(J) = 1 THEN PRINT "
      Insulin lowers the blood g
      lucose      concentration."
11020 IF C(J) = 2 THEN PRINT "
      Glucagon raises the blood
      glucose      concentration."
11030 IF C(J) = 3 THEN PRINT "
      Antidiuretic hormone lower
      s the      blood osmolality
      by inhibiting urine      forma
      tion."
11040 IF C(J) = 4 THEN PRINT "
      Parathyroid hormone (PTH)
      raises the blood calcium con
      centration."
11050 IF C(J) = 5 THEN PRINT "
      Thyroxine increases the ba
      sal      metabolic rate (B
      MR) to the set level."
11070 VTAB 20: PRINT "If you wis
      h to review the hormone list
      press 1. If not, press RE
      TURN to      continue."
11080 GET RH#
11085 HOME
11090 RH = ASC (RH#)
11100 IF RH = 49 THEN GOSUB 170
      00
11110 RETURN
13000 REM HOR AXIS
13010 IF C(J) = 1 OR C(J) = 2 THEN
      GOTO 13020
13015 GOTO 13500
13020 HTAB 8: VTAB 21
13030 PRINT "0      20      40
      60      80"
13040 VTAB 22: HTAB 20
13050 PRINT "MINUTES"
13060 GOTO 13600
13500 VTAB 21: HTAB 8
13510 PRINT "0      1      2
      3      4"
13520 VTAB 22: HTAB 21
13530 PRINT "HOURS"
13600 VTAB 23: HTAB 10
13610 PRINT "1.INS 2.GLU 3.ADH 4
      .PTH 5.THY"
13620 RETURN
17000 REM HORMONE LIST
17010 VTAB 2: HTAB 11
17020 PRINT "***HORMONE LIST***"

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17030 VTAB 4: PRINT "1. INSULIN-
      lowers the blood glucose co
      ncentration."
17040 PRINT : PRINT "2. GLUCAGON
      - raises the blood glucose
      concentration."
17050 PRINT : PRINT "3. ANTIDIUR
      ETIC HORMONE (ADH)-
      decreases the blood osmolal
      ity by      inhibiting urin
      e formation."
17060 PRINT : PRINT "4. PARATHYR
      OID HORMONE (PTH)- raises
      the blood calcium concentra
      tion."
17080 PRINT : PRINT "5. THYROXIN
      E- increases the basal
      metabolic rate."
17083 VTAB 21: HTAB 2
17085 PRINT "*PRESS RETURN FOR E
      XPLANATORY NOTES*"
17090 GOSUB 20000
17095 VTAB 6
17100 PRINT : PRINT : PRINT "NOT
      ES: The basal metabolic rat
      e is the metabolic rate of a
      person who is      conscio
      us and at rest. The blood
      osmolality is a measure
      of the      concentrati
      on of solutes dissolved in
      the blood."
17110 GOSUB 20000
19950 RETURN
20000 VTAB 23: HTAB 8
20010 INVERSE
20020 PRINT "PRESS RETURN TO CON
      TINUE"
20030 NORMAL
20040 GET RR#
20050 RR = ASC (RR#)
20060 IF RR < > 13 GOTO 20040
20070 HOME
20080 RETURN

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1430-60 4 Sh
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