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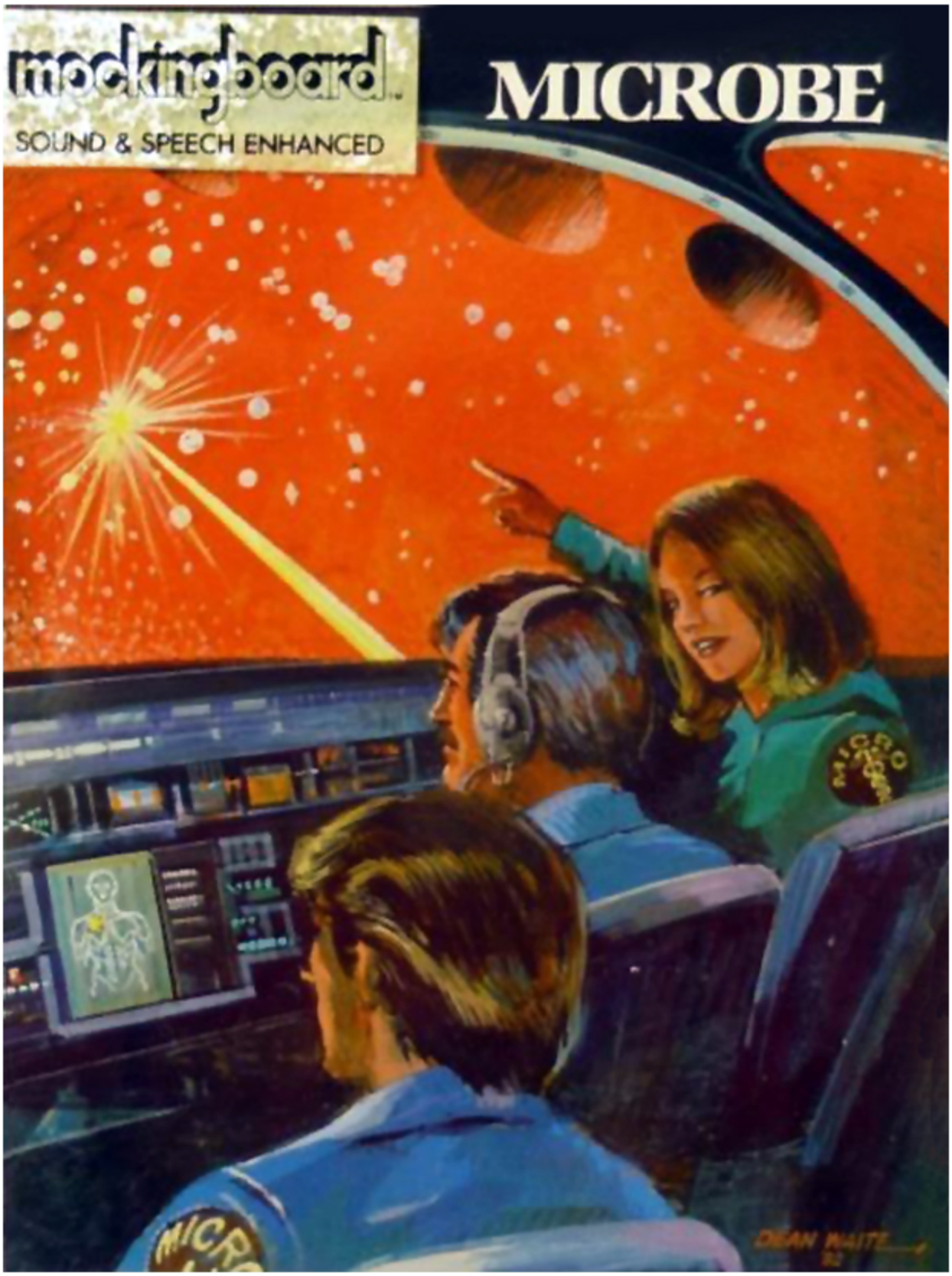

Synergistic Software Presents

EDUVENTURE #1

MICROBE:
The Anatomical Adventure

by

Robert C. Clardy and Alan H. Zalta, M.D.

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SECTION 1: INTRODUCTION

Microbe: The Anatomical Adventure is a computer program directed at a number of diverse users with differing goals. The best way to describe Microbe is to do it twice.

MICROBE: The Game

Microbe is an action packed exciting adventure game in which you plan and execute a complex mission in an environment that is both familiar and utterly alien: the human body. While the places, objects, and hazards you face may have familiar names, you have never before seen them from this point of view.

Strategic planning, adventure-like problem solving, and arcade-like fast action response are all required to make your way through the maze of vessels in the body to the brain. Can you accomplish your mission in time and save the critically injured patient while fending off attacking bacteria and parasites and dodging clots and tumors? Only time will tell.

MICROBE: The Educator

Microbe is an educational simulation of both the human body and its contents and the operation of a sophisticated research submarine. The information presented in Microbe on a wide variety of topics is designed to be both interesting and challenging to students from grade school through college up to medical students and physicians wishing to brush up on their immunology and diagnostics. The difficulty level and information required from the player can be varied to maintain the proper challenge for each of these diverse groups. The program also presents information on a variety of health and safety topics from smoking and drinking, to seat belts and safety rules. There is something for everyone in Microbe.

The original design of Microbe was done jointly by Robert C. Clardy and Alan H. Zalta, M.D., a physician and resident

ophthalmic surgeon at the University of Arkansas for Medical Sciences, in Little Rock, Arkansas. In addition to Dr. Zalta's own experience, research was done to insure that all aspects of the game were medically correct and realistic. A bibliography of the primary sources appears at the end of this handbook.

The program includes a wealth of information about anatomy, immunology, the effects of brain damage, medical emergencies, drugs and their uses, and the many ailments that the body is subject to. The latter includes both injuries such as hemorrhages and clots, as well as the myriad bacteria, viruses, parasites, and fungii that may infect the body. While you can learn much about medicine from this program, remember that medicine is too complex a subject with too many dangers to be practiced by the novice. DO NOT try to apply the information in this game to self-diagnosis or treatment. You do not have the viewpoint that this game presents, so your own guesses could not be as accurate as the diagnosis of a qualified physician.

For the sake of game playability, several liberties were taken. These are described in detail at the end of the Physician's Reference manual.

SECTION 2: SCENARIO

On January 14, 1990, a long term secret government project was finally completed. A miniaturization device had been built that could shrink any form of matter down to microscopic size without altering its essential structure and form. Subsequent testing of this device revealed that a submarine and crew could be miniaturized and injected into a human body. While the initial work on the miniaturizer was for military purposes, this spin-off application revolutionized medical research and micro-surgery. In particular, many delicate operations within the brain which heretofore had been inoperable, could now be cured using this revolutionary technique.

In November 1990, an organization was formed to monitor and direct the miniaturization surgery activities of all the countries that had become involved. That organization was called Miniaturization: International Centralized Research Organization or M.I.C.R.O. for short. Utilizing specially designed submarines (referred to as Microbes), they have been treating critically injured patients since that time.

You are a newly trained Microbe commander and are about to embark on your first mission.

SECTION 3: GETTING STARTED

To begin playing MICROBE place the diskette in your disk drive and turn on your computer. The game will automatically run. You will first be asked to press 'C' to continue a previously saved game. Press any key to start a new game. If you select a new game, you will be presented with a number of options to choose from. These are explained in SECTION 4. You may then select a case (see SECTION 5) and begin your mission.

SECTION 4: VARIATIONS OF PLAY

When you begin a Microbe mission, you will be presented with the options listed in Table 1. The play of a game can be changed drastically by selecting among these options. The options in effect will be shown in inverse on your screen. To select any other option, simply press the number adjacent to each. The default choices (the selection which will be in effect if the adjoining number is not pressed) are indicated in parentheses below. The variations among options are as follows:

TABLE 1
MISSION OPTIONS

(1) PLAYERS (default = ONE) - Microbe is set up for individual or group play. Anywhere from one to ten people can play the game. With one player information is provided from the sub's physician. More than one player requires more use of the manuals. Refer to the Group Play section.

(2) BACKGROUND (default = GAMER) - The sub's physician will provide you with diagnostic and treatment information if you do not specify that you have medical knowledge. STUDENT and PHYSICIAN players will be provided less information by the program.

(3) SKILL (default = 1) - There are three different skill levels. At higher numbered skill levels, the game becomes increasingly difficult. There are more attacks, faster play, more hits from attackers, worse damage from each hit, less air, less fule, and less time at higher skill levels. You also get more points for successful actions at each higher skill level you select. At the highest level (3), the game pause feature (ESC key) is not available during attacks.

(4) TALKING APPLE (default = NO) - If you have a VOTRAX Type and Talk, ECHO-GP or comparable speech synthesizer attached to your Apple, select yes. The program assumes that such a device is in slot 3. Your ship's computer can then speak to you as required.

(5) EMPHASIS (default = HEALTH/SAFETY) - This option refers to the types of cases you will be working on. HEALTH/SAFETY cases are children and young adults who have been injured in a home or driving accident. Topics covered include seat belts, drinking while driving, no safety lights or helmets, etc. MEDICINE cases are generally older adults with either medical emergencies (such as stroke, heart attack, or tumors) or injuries sustained during attacks of one sort or another. MEDICINE cases also typically have more degenerative problems such as emphysemic lungs, cirrhosis of the liver, ateriosclerotic vessels, etc.

GROUP PLAY

With more than one player, the Microbe game is altered. Less information is provided by the ship's computer, requiring the players make more use of the various handbooks during the mission. Specifically, the following changes occur...

(1) The blip indicating the sub's position on the various navigational body maps is omitted. Players must track their position using the Navigator's Chartbook.

(2) The prescription feature of the on-board physician is omitted. Players must refer to the Physician's Reference for appropriate treatments.

(3) The conclusions to be drawn from a blood sample are omitted. Players must interpret immunogen levels using the charts in the Physician's Reference.

(4) Circuit breaker activation is required as detailed in the Technician's Manual.

When a group plays, duties should be divided as indicated below. When an emergency situation or attack occurs, ESC

should be pressed to halt the game while the appropriate course of action is discussed. Similarly, the game can be halted periodically to allow players to rotate positions, giving everyone a chance at each position.

POSITION	FUNCTION
1.	Keyboard - Command inputs.
2.	Paddle 0 - Laser aim and fire.
3.	Paddle 1 - Sub steering and speed control (Somewhat tricky. Practice this carefully).
4.	Technician's Manual
5.	Navigator's Chartbook
6.	Physician's Reference
7.	Captain's Handbook

1 or more players can refer to each manual continuously as required during the mission.

SECTION 5: SELECTING A CASE

After you have specified the play options you desire, you can flip through the M.I.C.R.O. casebook and select a case. If the first case displayed is not to your taste, press the space bar for another. When you find one you like, press RETURN to accept it. All patients are frozen in cryogenic stasis, so there is no more urgency for one over another.

In selecting a case, you should make note of the victim's ***past medical history.*** A patient with emphysema from smoking and cirrhosis of the liver from excessive drinking will introduce more problems in the mission than will a healthy patient. The Physician's Reference book discusses pre-existing medical problems in more detail.

You should also make note of any allergies the patient may have. In the patient's weakened condition, causing an allergic reaction by administering the wrong drug could prove fatal.

After you accept a case, a summary description of the medical problem is presented. Make particular note of the location and nature of the problem you are being sent in to cure. Do not waste time searching brain vessels for the correct lesion (damage). The various lesions that you may have to deal with are listed in Table 2 while Table 3 lists the vessels in the brain where the damage may occur and the associated symptoms. Refer to the Navigator's Chartbook for the location of each vessel in the brain.

TABLE 2
BRAIN LESIONS

LESION	DESCRIPTION	TREATMENT
THROMBUS	Blood clot lodged in vessel.	LASER
HEMANGIOMA	Vascular tumor blocking vessel.	LASER
ANEURYSM	Weakened vessel wall has ballooned out and may burst.	GELFOAM
TUMOR	Tissue growth blocking vessel. Examples include Glioma, Meningioma, etc.	LASER
FRAGMENT	Piece of bone, bullet, shrapnel, etc. lodged in vessel wall.	LASER
HEMORRHAGE	Hole or holes in vessel wall through which blood is leaking into surrounding tissue.	GELFOAM

TABLE 3
DAMAGE SITES

ARTERY	SYMPTOMS
Middle Cerebral	Communication recognition problems paralysis, etc.
Ophthalmic	Vision and eye problems, hallucinations, etc.
Anterior Cerebral	Distraction, paralysis, loss of sensation, etc.
Posterior Cerebral	Motor problems (spasticity, control, etc.), memory problems, etc.
Posterior Cerebellar	Coordination, balance, and hearing problems, etc.

After you have reviewed the medical situation, press RUN and the mission will begin. The Microbe submarine will be reduced to microscopic size and injected in the leg of the selected patient. Thereafter, you will have a limited amount of time (varies depending on patient's condition) to accomplish your mission and escape from the body via the eyes (refer to Navigator's Chartbook).

THE CAPTAIN'S MANUAL
M.I.C.R.O. DOCUMENT 37-A1000A2

SECTION 6: COMMANDING THE MICROBE

The Microbe medical research submarine is a fully automated vessel that can carry a crew of 4. Normally, the crew will consist of a captain, a navigator, a technician, and a physician. Briefly, their duties are:

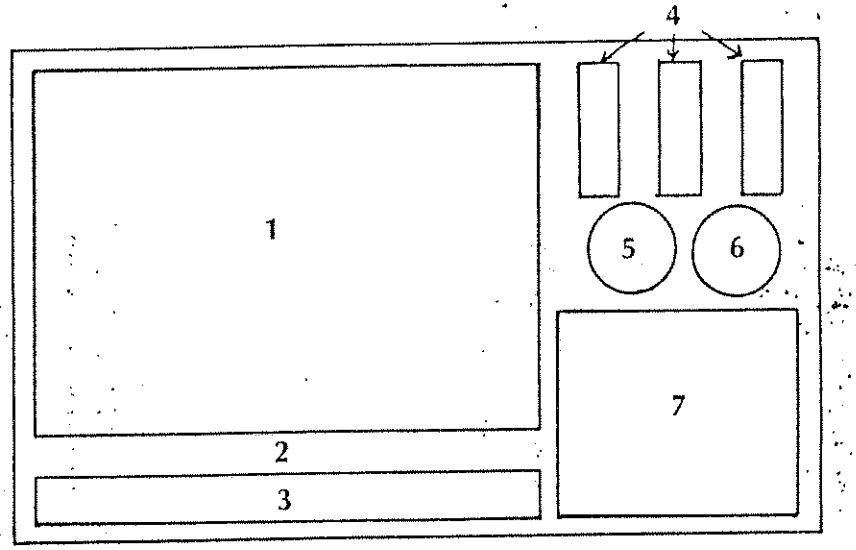
CAPTAIN — The pilot and mission commander. Steers the Microbe and issues all commands, directing both the submarine itself and all other crew members.

NAVIGATOR — Can display maps of the body, its blood vessels and organs, and track the submarine's position based on coordinate information provided by radio from external monitors.

TECHNICIAN — Repairs any damage done to the submarine. Also performs any diving required, both for repairs and for organ hookups.

PHYSICIAN — Will identify attacking immunogens and micro-organisms, perform blood analyses, monitor patient's vital signs, and recommend treatments.

FIGURE 1
MAIN CONTROL PANEL



THE DISPLAY

As captain, you will monitor the mission's progress on your display panel illustrated in Figure 1. This display panel can provide a wide range of information. The instruments operate as follows:

1. Master View Screen —

   a) Can display a closed circuit TV view outside the sub; useful for viewing attackers and other micro-organisms and body cells. This view is necessary to aim your laser when firing at attackers. This view will be referred to as View Mode 1.

   b) Can display a computer generated map of the immediate surroundings, including the local vein, artery, or organ, all red blood cells, other cells, and your submarine's location. This view will be referred to as View Mode 2, and is used to steer the sub.

   c) All body maps are displayed here.

   d) Large information displays such as blood samples, inventory lists, and library information appear here also.

2. Indicator Lights — Come on only when you are critically low on air, fuel, oil, or battery power. Patient emergency condition is also indicated here.

3. Message Window — Normally, this window displays the sub's speed and the time left to complete your mission. The window also displays computer reports such as damage notices, repair information, etc.

4. Gauges — Provide a continuous measure of your air, fuel, and battery levels. Note that battery continually recharges whenever your engine is on.

5. Sonar — Provides an approximation of an attacker's location. With the approximation, you can locate an attacker in your view screen.

6. Compass — Displays the sub's heading. The small line indicates Laser aim.

7. Status Window —

   a) All commands given are displayed here. Refer to Command Section.

   b) Displays status of ship, crew, patient, and mission upon request.

COMMANDS

Your automated submarine (and the crew) are controlled by simple, single keystroke commands. Some of the commands require additional selections to be carried out. In those cases, command menus such as those illustrated below will appear as needed. The basic commands are:

COMMAND KEY	PURPOSE
N	NAVIGATOR. Issue a command to the navigator. Specify which map you wish to display.

NAVIGATOR
1. BODY 2. HEAD 3-4. L/R ARM 5. CHEST 6. ABDOMEN 7/8. L/R LEG WHICH?

T

TECHNICIAN. Issue a command to the technician. The REPAIR option will require you to specify which subsystem to repair. (See menu below.)

TECHNICIAN
1. Repair 2. Dive 3. Report 4. Circuit Breakers WHICH?

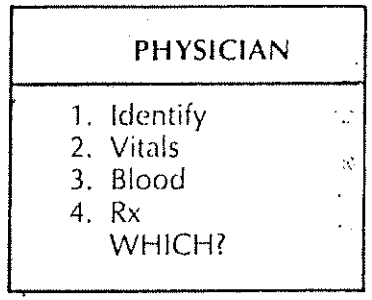
REPAIR WHAT?
1. HULL 2. SONAR 3. LASER 4. RADIO 5. COMPASS 6. ENGINE 7. FUEL TANK 8. COMPUTER 9. LIBRARY

The DIVE option should be used to repair external damage.

The REPORT option will display a progress report about the repair underway. ETC (Estimated Time to Completion) is continuously updated.

The CIRCUIT BREAKER option will require you to type the number of the circuit breaker you wish pressed. Press 1 digit and Return key for 1-9 or just two digits (no Return) for 10-99. See Technician's Manual. This command is only valid during group play or advanced skill levels.

P



PHYSICIAN. Issue commands to the physician.

IDENTIFY will provide you with the name of the current attacker.

VITALS will display the patient's vital signs including pulse and blood pressure as well as describing the patient's condition (stable, hypertensive, in shock, cardiac arrest, etc.; see Physician's Reference).

The BLOOD command will perform a blood sample and analysis and display the results.

Rx will provide recommended treatments (not available in group play mode or to players with a medical background).

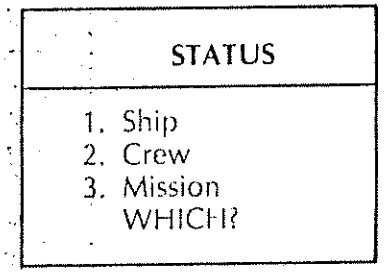
V

VIEW. Switches the view screen between the two primary viewing modes. Mode 1 is the closed circuit TV external view. Mode 2 is the steerage display which shows an overview of the blood vessel (or organ) that your sub is in. The sub's position is indicated as well as nearby cells. This view is required for movement through the body. The engine is automatically not in gear if this display is not active.

E

ENGINE. Turns engine on or off. When the engine is on, your battery will recharge. If you are looking at View Mode 2 (the steerage display), the sub will move forward at a speed of 10 knots. Speed can be varied by use of the space bar or paddle 1 pushbutton. Press either to increase your speed 5 knots. If you press it while travelling at your maximum 20 knots, you drop back to a minimum speed of 5 knots.

S



STATUS. Lets you display the current status of your ship, your crew, the patient, or the mission. The status of each ship subsystem will be either OK (no problems), OUT (damaged, not repairable), OFF (repaired but not turned on), or a number from 20-200 (time required to repair it).

Crew member status will be OK, UNCONSCIOUS (not available for some undetermined time), or DEAD.

Mission status displays the sub's coordinate location, your score or SUCCESS FACTOR and the selected skill level and nature of the mission commander.

L

LIBRARY — The ship's library can provide information about the nature, appearance, and treatment required for any possible attacker. You can access the library by selecting the name of an immunogen or micro-organism from a menu, or by selecting from

	pictures of all possible attackers. Consult the Physician's Reference for a list of possible attackers.
Q	QUIT — Terminates the mission. You can save the mission for completion later if you wish. The patient will be placed in a cryogenic status until you return to complete the mission.
ESC	HOLD — Places the mission on hold temporarily. Resume by pressing any key.
#	SOUND — Transfers sound effects to the cassette output. If no external speaker is connected, this effectively turns off the sound.
B	BLINK — Turns the blinking indicator lights on or off.
space bar or paddle 1 button	SPEED — Increases the speed of the sub. Press the space bar to step speed up to 20 knots, after which it drops back to 5 knots. You may use paddle button #1 for the same function.
Arrow keys or Paddle 1	Steers sub.
Paddle 0	Aims laser in either view mode.
Paddle 0 button	Fires laser in either view mode.
?	HELP. Displays a list of commands.

SECTION 7: THE MISSION

After you have been injected into the patient's leg, you must make your way to the brain. Your first step should be to check your current position using the Navigator's maps. Once you know your location and where you are going, switch your viewport to Viewing Mode 2, turn on your engines and begin.

You will immediately encounter your first potential hazard. You can run into red or white blood cells and jar the ship. Such collisions can cause minor damage or even injure crewmen if they are not strapped in. You should, therefore, steer to avoid all contact with other objects such as floating cells and vessel walls.

At some time during the mission, you may also encounter other problems in the body. There may be blood clots or tumors (use your laser to break them up), sclerotic arteries (you must steer around the deposits on the vessel walls), fragments of bone or metal (use your laser), or hemorrhages (seal using gelfoam). The patient's chances are improved if you properly treat these problems as you encounter them. You should be very careful with the laser, however. It can be directed using paddle 0 and can easily be made to shoot vessel walls. This will cause hemorrhaging (flow of blood from the vessel to the surrounding tissue) and must be repaired immediately using gelfoam. You only have 10 units of gelfoam, so do not waste it. Untreated hemorrhages can lead to shock, cardiac arrest, and eventually, death.

During your mission you may also be attacked. Attacks are usually from the body's own defenses, the immunological system composed of white blood cells, antibodies, and antigens. Refer to Physician's Reference for a complete list. You may also be attacked by any of a large number of bacteria, viruses, parasites, or fungii which may be in the patient's body. These are also listed in the Physician's Reference.

Whenever an attack occurs, you should perform a blood sample analysis. If any immunogen level is high, that indicates what the attacker is, and you can fight it appropriately. If no immunogen is high, the attacker is a micro-organism. When it gets close enough: your physician can identify it for you. At that point, you can check your library for the appropriate treatment or, in skill level one games, ask the physician for the treatment.

Whatever the nature of the attacker, you then have two options. You can destroy the attackers using your laser (the sonar will help you tell which organism is the attacker) or use the appropriate treatment(s). The latter is usually drugs but may be ionizing radiation from your portable X-RAY. You should never use the X-RAY in an organ, however, as damage to the organ will trigger a massive immunogen attack.

If you do not destroy an attacker quickly enough, it will hit the sub and cause damage to the ship's subsystems (see Technician's Manual) or injuries or death to the crew. Losing crew members will make the mission much more difficult and is, therefore, not recommended. When an attack begins, handle it quickly.

Besides the obstacles and attackers, you may also have to deal with a variety of medical emergencies such as seizures and cardiac arrest. The Physician's Reference lists the emergency conditions and their appropriate treatment. It should be noted that in the victim's weakened state, emergency conditions will quickly cause a deterioration leading to death.

On the way to the brain, you may pass through several other organs. Each has its own peculiarities. The Navigator's Charts provide more detail on each.

THE KIDNEYS — There is a location in each kidney (see Navigator's Charts) where you can use your Kidney Hookup device to coat the sub with an immune suppressant which we refer to as a "cloaking device". The cloaking device makes the sub invisible to the body's immune system and prevents all further attacks from that source. The kidney also contains a filtering vortex (whirlpool) that leads to the bladder. If the sub

enters the vortex, it will be sucked through and urinated out of the body — an inglorious end to the mission.

THE LIVER — The liver (among its other functions) maintains excess glucose stores (body's sugar reserves) for the body. You can use your Liver Hookup to tap these stores and convert them to extra fuel. If you accidentally enter the biliary/intestinal trap, however, you will be processed through the intestines and excreted out of the body - an even more inglorious end to the mission.

THE LUNGS — You will need to pass through the lungs at least once on your way from the venous system (the veins which return blood from the body's cells to the heart) to the arterial system (arteries which take blood freshly oxygenated by the lungs to the rest of the body). The lungs form a complex maze of passages that you must wind your way through. Be sure to track your progress on a map. You may use your Lung Hookup to get more air for your sub. While in the lungs, you may need to use your laser to blast through mucous plugs or secretions (which will be much worse if the patient has any lung problems such as emphysema or bronchitis). Be very careful not to puncture the air sac walls of the lungs, however, or you will be sucked out and exhaled — end of mission.

THE HEART — Passage through the heart must occur twice. The heart consists of two pumps. The first pump receives blood from the venous system and pumps it to the lungs. The second pumps blood from the lungs into the arterial system and thence to the rest of the body. In both of your sub's passages, the heart must be stopped. Cardiac arrest (stopped heart) can be induced with your defibrillator. Once stopped, you have only about 15 seconds to make the passage and restart the heart (see Cardiac Arrest in Physician's Reference) before the patient dies.

SECTION 8: MISSION SUCCESS OR FAILURE

In its simplest form, the success of your mission is measured solely by whether or not you repair the brain lesion and escape from the body. This is the only critical goal in the mission. However, in the interest of determining the relative abilities of our various mission commanders, a scoring system has been established as detailed in Table 4. Note that higher scores are given at higher skill levels since only the most difficult cases are given to the more skillful mission commanders. The highest score attained and an average score over time are saved for future reference.

No score is awarded if the mission fails. Your score at the time of failure will be displayed but not saved. The mission can fail if:

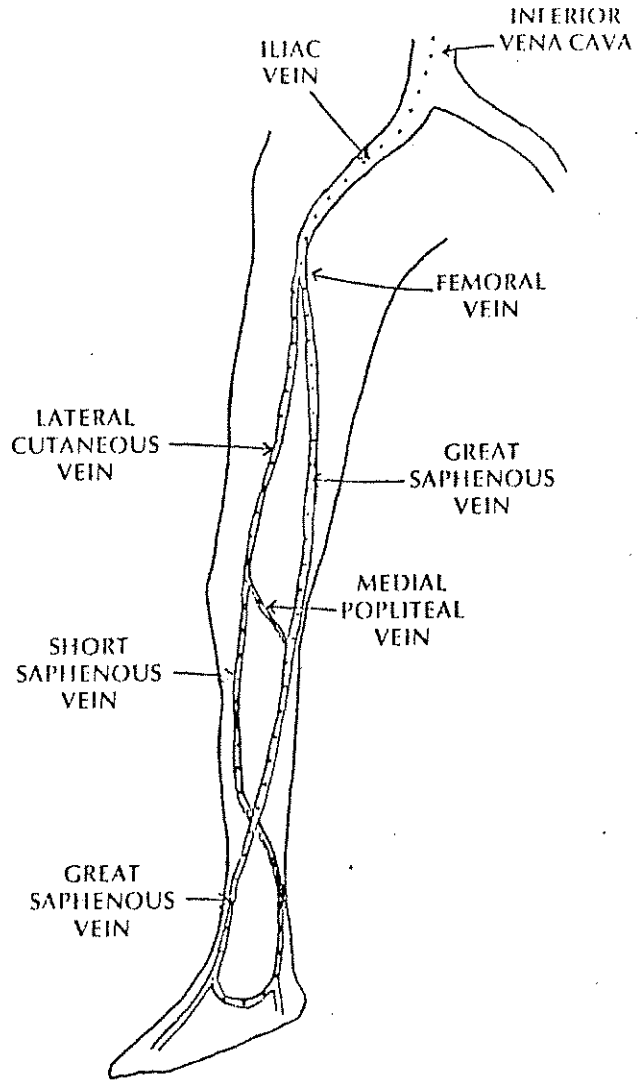
1) You run out of time and the patient dies.
2) You run out of fuel and drift helplessly.
3) You run out of air and the crew dies.
4) You break a blood vessel and are sucked out into the surrounding tissues and are trapped.
5) You administer a drug which causes an allergic reaction and kills the patient.
6) You do not properly treat an emergency condition such as cardiac arrest.
7) You puncture a lung air sac wall and are sucked in and exhaled.
8) You are filtered out of the kidneys and urinated out of the body.
9) You accidentally enter the liver's biliary system and are excreted from the body.

TABLE 4
POINTS

ACTION	POINTS		
	SKILL 1	SKILL 2	SKILL 3
DESTROY RED BLOOD CELLS	-5	-10	-15
DESTROY FOREIGN MICRO-ORGANISM	10	20	30
DESTROY ATTACKING MICRO-ORGANISM	50	100	150
BREAK UP BLOOD CLOT, TUMOR*, FRAGMENT	100	200	300
REPAIR HEMORRHAGE*	100	200	300
CAUSE HEMORRHAGE	-100	-200	-300
ACCOMPLISH LUNG HOOKUP	200	400	600
ACCOMPLISH LIVER HOOKUP	200	400	600
ACCOMPLISH KIDNEY HOOKUP	200	400	600
TREAT EMERGENCY CONDITION	300	600	900
ACCOMPLISH PRIMARY MISSION	2,000	4,000	6,000
KILL A CREW MEMBER	-500	-1,000	-1,500
TIME LEFT ON CLOCK AT END OF MISSION (POINTS PER SECOND).	2	4	6

*If unrelated to primary mission.

CHART 7
LEG



MICROE

NAVIGATOR'S CHARTBOOK

M.I.C.R.O. Document 37-C496A1

This manual contains the charts you will need to find your way through the human body. Only those vessels and organs that are large enough for the sub's passage and which lead toward your goal are shown. All other veins, arteries, capillaries, organs (stomach, intestines, colon, etc.), body cavities (ears, sinuses, pleural cavity, etc.), and other body systems (nervous system, lymphatic system, etc.) have been omitted to avoid unnecessary confusion.

A simple coordinate system (illustrated in the Body map) has been established to help you in determining your position in the body. The mission status display includes your coordinates and all maps have the vertical coordinate displayed. If you are playing alone and your radio is working, external scanners will produce an orange marker on any map that includes your position. If you are playing in a group, it is the navigator's responsibility to track the sub's position.

You will normally be injected into a convenient leg vein. From the point of injection, you must make your way to the heart travelling with the flow of blood (see body map). From there, you will pass through the heart and lungs and enter the arterial system which carries blood from the heart to the body's cells. Follow the aorta to the vertebral artery or left common carotid artery (see head map). You will then follow these to the brain. Once in the brain, you must make your way to the blood vessel in which the problem occurs (see brain map), resolve the problem, then travel out the ophthalmic artery to the eye for removal via the tear ducts.

During your mission, it may become desirable to stop in the lungs (to get more air), the liver (to tap glucose stores to manufacture fuel), or the kidneys (to obtain immunogen cloak). Study the maps of these organs carefully to avoid the various pitfalls of each.

CHART 1
THE HUMAN BODY

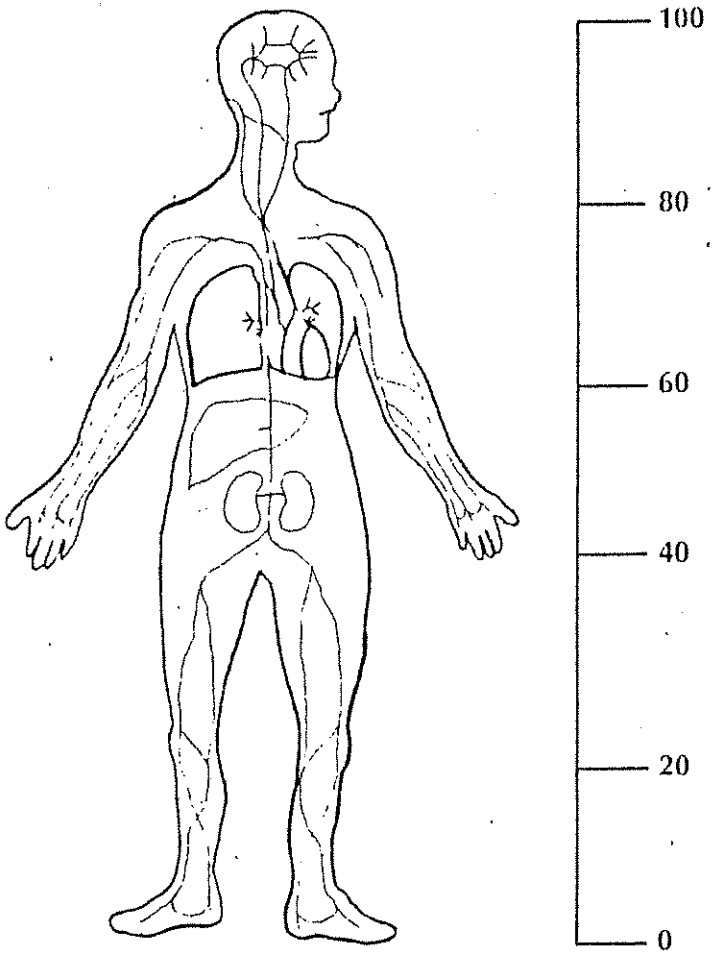


CHART 2
HEAD and BRAIN

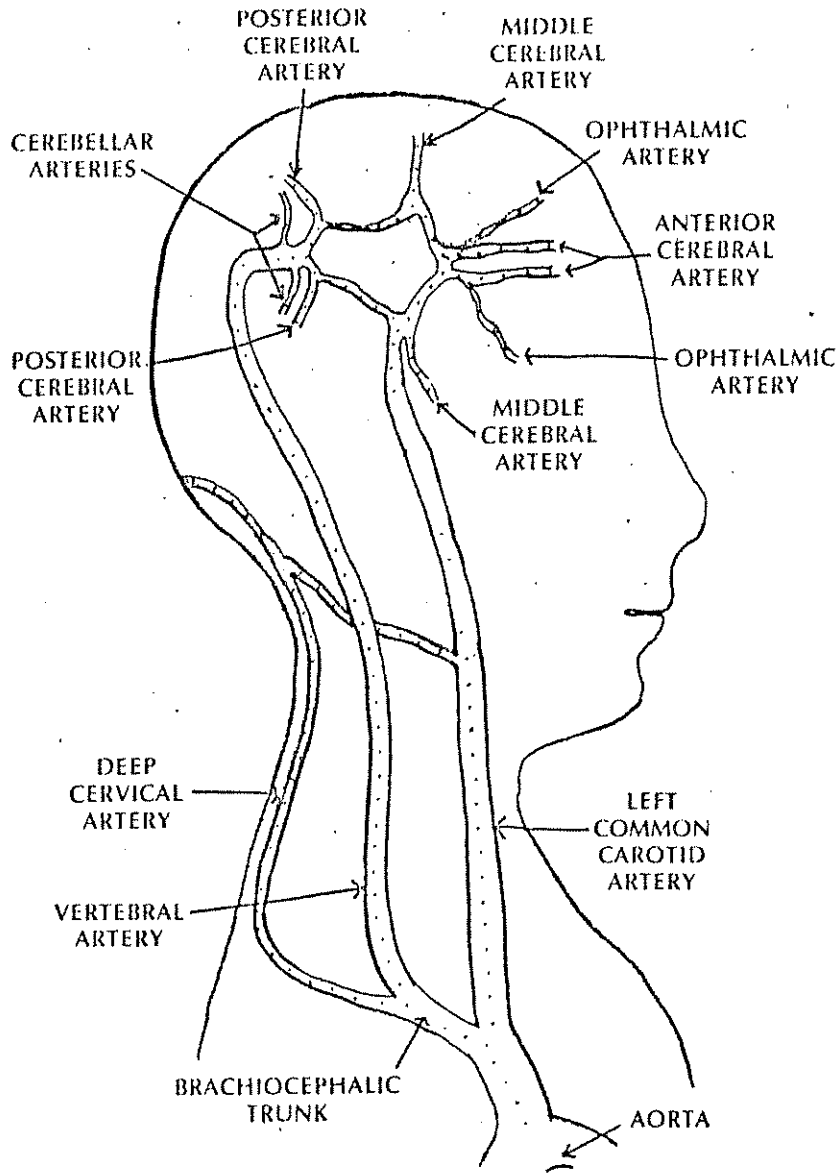


CHART 3
ARM

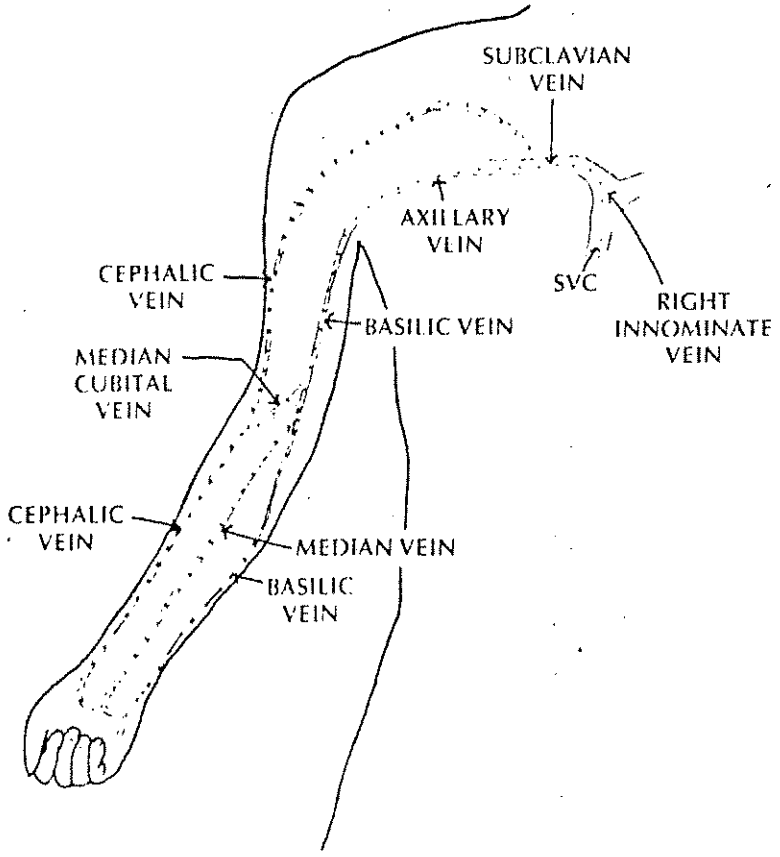


CHART 4
CHEST (View 1)

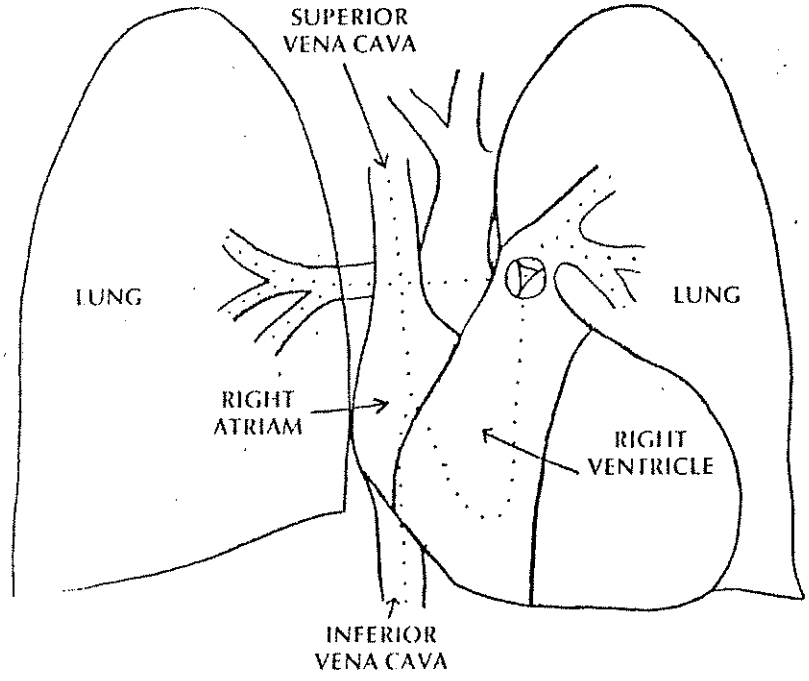


CHART 5
CHEST (View 2)

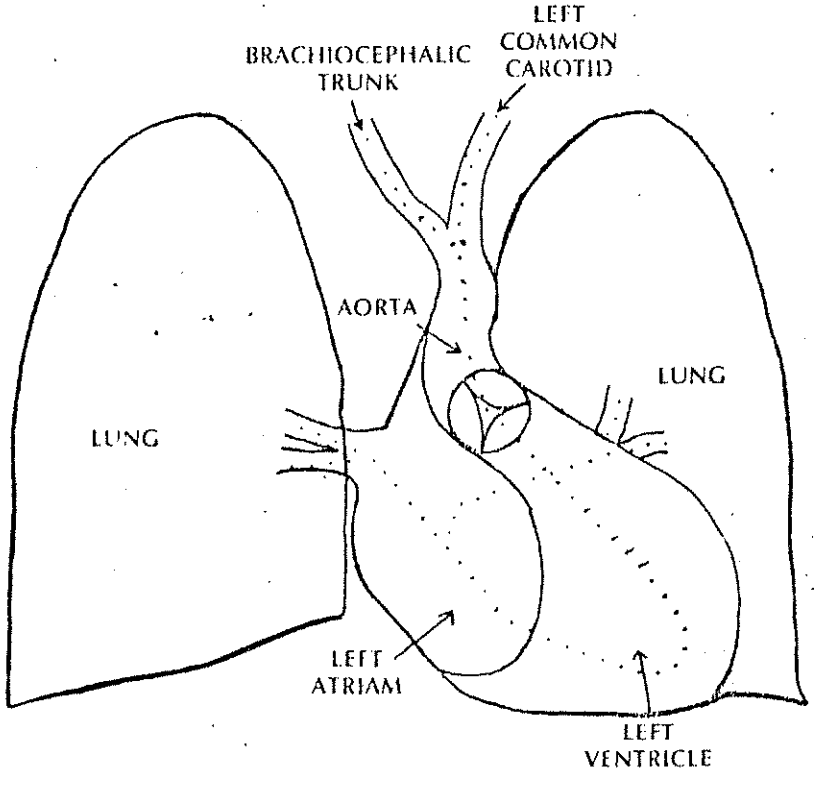
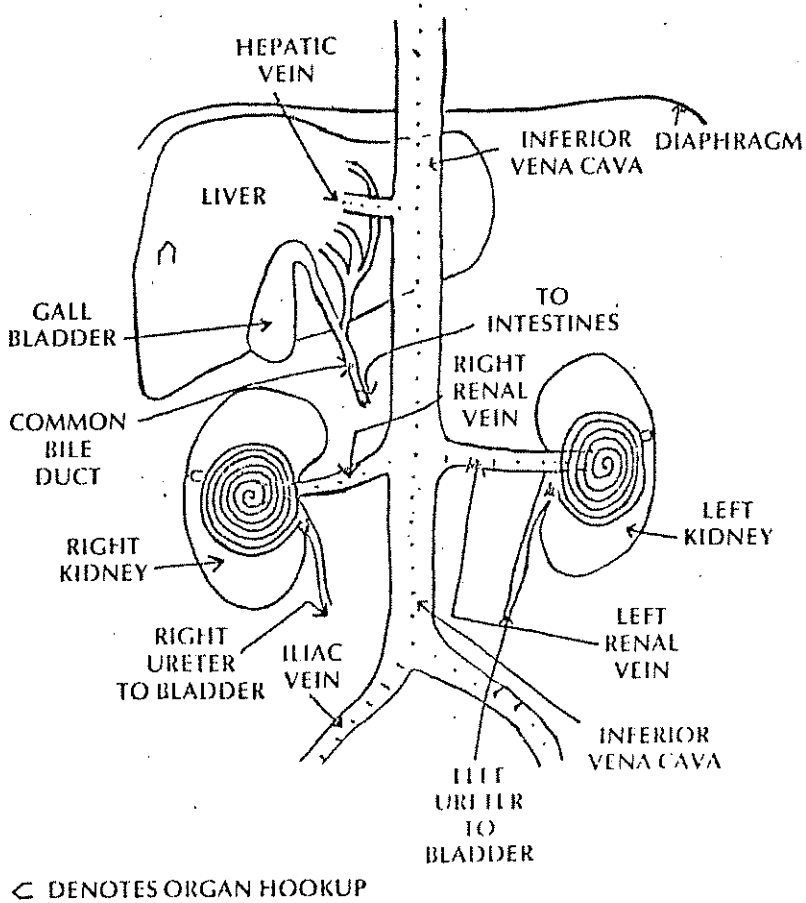


CHART 6
ABDOMEN



⊂ DENOTES ORGAN HOOKUP

MICROBE

TECHNICIAN'S MANUAL

M.I.C.R.O. Document 37-A198B5

SECTION 1: MICROBE SUBSYSTEMS & DAMAGE

This manual contains a simplified overview of the subsystems, power network, and stores of the Microbe submarine. During the course of the mission, it will be the responsibility of the technician to monitor the stores, repair any damage to the submarine and control power distribution as required to insure that all subsystems are operable when needed.

The major subsystems of the Microbe submarine that are susceptible to damage are listed in Table 1. The effect of damage to these subsystems is also listed. It should be noted that damage to the engine, laser, or hull may be external or internal. If the damage is external the technician should put on scuba gear, leave the submarine, and perform the needed repair. Under no circumstances should a dive be made during an attack on the sub, during seizures, or for any unnecessary reason.

TABLE 1
SUBMARINE SUBSYSTEMS

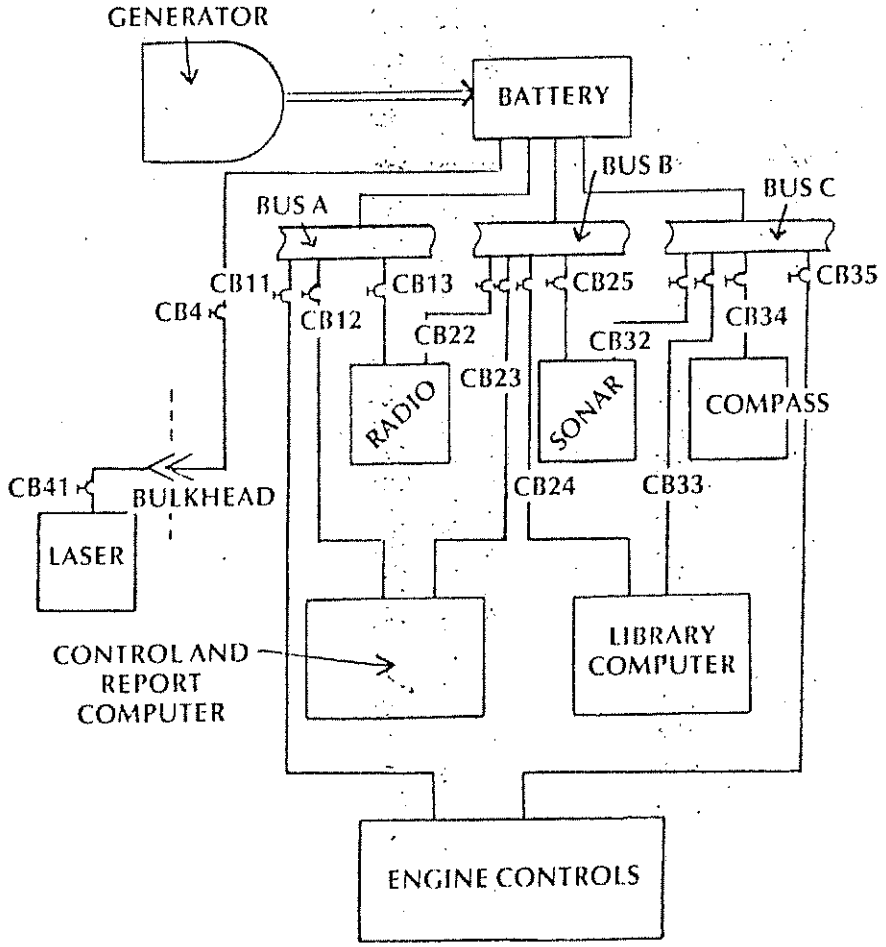
SUBSYSTEM	EFFECT OF DAMAGE
1. HULL	Loss of air at twice normal rate
2. SONAR	Inability to locate attackers
3. LASER	Inability to shoot attackers, clots, tumors, etc.
4. RADIO	Loss of sub locater and use of IV fluids*
5. COMPASS	Loss of direction indicator, steering is difficult
6. ENGINE	Loss of all forward motion
7. FUEL TANK	Loss of fuel at twice normal rate
8. COMPUTER	All text displays and readouts will be garbled
9. LIBRARY	Loss of information about attackers

*IV fluids are administered by the hospital staff only at the radio command of the mission commander.

SECTION 2: CIRCUIT BREAKERS & POWER

After a repair is completed, you must activate the required circuit breakers to return power to the repaired subsystem. The system will remain inactive and unusable until the correct breakers are closed.

FIGURE 1
POWER DISTRIBUTION



To determine which circuit breakers should be activated refer to the power distribution diagram in Figure 1. Locate the unit which has just been repaired. Follow the power lines from it back toward the generator. You should activate the first circuit breaker encountered on each line. For instance, to turn on the radio's power, you must activate circuit breakers 13 and 22 (labeled on the chart as CB13 and CB22).

When damage to the subsystem occurs, a computer-generated warning message will be displayed. You should immediately check the extent of damage using your ship's status display and initiate appropriate repairs. Next to each subsystem in the status display will appear one of 4 indicators. These are:

1) OK — No damage to subsystem
2) OFF — Subsystem has been repaired but not yet turned on. Activate its circuit breakers (see power distribution schematic).
3) 0-200 — Damage indication. Number is an estimate of the amount of time required to repair the damage
4) Out — Subsystem is damaged and not repairable.

The technician can only work on one subsystem repair at a time. Therefore, in the event of multiple failures choose the most critical system to repair first.

NOTE: A limited number of new, improved Microbe submarines are available. These have automatically operating circuit breakers. These subs, because of their current scarcity, will only be assigned to less experienced individual mission commanders. A novice skill level will not, therefore, require the activation of circuit breakers.

SECTION 3: EQUIPMENT AND DRUGS

At the beginning of the mission, the technician has seen to the loading and storage of the equipment and supplies that may be needed. That equipment is listed in Table 2.

TABLE 2
INVENTORY

#	ITEM	QUANTITY
1.	FUEL TANK	8
2.	OXYGEN TANK	12
3.	KIDNEY HOOKUP	1
4.	LIVER HOOKUP	1
5.	LUNG HOOKUP	1
6.	X-RAY MACHINE	1
7.	ANTIHISTAMINE	3
8.	CORTICOSTEROID	3
9.	DESENSITIZER	3
10.	ANTILYMPH. SERUM	3
11.	CHEMOTHERAPY	3
12.	INTERFERON	3
13.	GAMMAGLOBULIN	3
14.	ACYCLOVIR	3
15.	HEPTAVAX-B	3
16.	PENICILLIN	3
17.	GENTAMICIN	3
18.	CEPHALOSPORIN	3
19.	CHLORAMPHENICOL	3
20.	TETRACYCLINE	3
21.	AMPICILLIN	3
22.	METHICILLIN	3
23.	CHLOROQUINE	3
24.	FLAGYL	3

TABLE 2
INVENTORY CONTINUED

25.	QUINICRINE	3
26.	DARAPRIM/SULFA	3
27.	THIABENDAZOLE	3
28.	PIPERAZINE	3
29.	AMPHOTERICIN	3
30.	DEFIBRILLATOR	1
31.	GELFOAM	10
32.	EPINEPHRINE	10
33.	LIDOCAINE	10
34.	BICARBONATE	10
35.	IV FLUID	10
36.	VASOPRESSIN	10
37.	ISOPROTERENOL	10
38.	DIGOXIN	10
39.	LASIX	10
40.	AMINOPHYLLINE	10
41.	DIAZOXIDE	10
42.	VALIUM	10

SECTION 6: MEDICAL INACCURACIES

Much research was done to insure that all aspects of the game are medically correct and realistic. For the sake of playability, the following liberties were taken:

(1) The probability of encountering some of the micro-organisms listed in the Physician's Reference is much higher in the game than in real life.

(2) A laser of the size the Microbe carries would scar or cauterize the walls of veins and arteries, not blow holes in them.

(3) Some of the treatments (such as for cardiac arrest) have been simplified so that timing is not as critical.

(4) The ability of the kidney to provide some substance which conceals or cloaks an invader from the body's defenses is unknown at this time.

(5) Interferon has only recently been synthesized. Its functional uses are still under investigation. We expect that its uses as described in the game will be among those available by the 1990's.

(6) The probability of occurence of some of the immunological disorders has been increased.

(7) The color and scale of some of the immunogens, organs, vessels, and micro-organisms may be slightly inaccurate due to the limitations of the Apple II and a color TV.

Aside from these few liberties, we believe the program and document to be medically accurate. If any other discrepancies are noted that cannot be accounted for by the more advanced medical science of the 1990's, please feel free to let us know.

PHYSICIAN'S REFERENCE

M.I.C.R.O. Document 37-B492B2

SECTION 1: INTRODUCTION

As the physician aboard the Microbe, it will be your responsibility to monitor the patient at all times to make certain that his/her condition remains stable. The patient's vital signs display will present blood pressure, pulse rate, and general condition. This display should be checked periodically to detect variations before they become a problem. Significant changes will be detected by the computer and a PATIENT warning light will come on to indicate a problem.

At any time, you can also perform a blood sample analysis to monitor immunogen levels, check the patient's computer generated emergency condition status, or request an identification scan of surrounding/attacking micro-organisms or immunogens.

The remainder of this reference manual will list the various medical problems you may encounter.

SECTION 2: BLOOD SAMPLES

The human body's vascular system into which you will be injected contains a fluid (blood) composed primarily of clear plasma. Floating in the plasma may be found red blood cells, white blood cells, antigens, and antibodies. All but the red cells are a part of the body's defensive mechanism and are called immunogens. As such, they can be expected to attack any foreign object in the body including your submarine. The table

below shows normal values for the blood's immunogens as well as typical levels that might develop if they are attacking a foreign body.

In the event of an attack on the sub, you should perform a quick blood sample to determine whether it is an immunogen attack. High levels of any of the immunogens indicate an attack. Consult your ship's library or physician for the appropriate treatment.

TABLE 1
IMMUNOGENS

IMMUNOGEN	NORMAL RANGE	TYPICAL ATTACK LEVEL
	(Per Micro Liter Unless Indicated)	
IMMEDIATE		
1. Neutrophil	1800-6500	1500
2. Immunoglobulin G (IgG)	800-1800 mg/dl	3300 mg/dl
3. Immunoglobulin M (IgM)	65-265 mg/dl	540 Mg/dl
4. Complements (Classic and Properdin)	Rare	Many
5. Basophil	0-100	200
6. Immunoglobulin E (IgE)	Rare	Many
7. Monocyte	120-800	1960
DELAYED		
8. Lymphocyte	4000-6000	30000
9. Lymphotoxin	Rare	Many
10. Lymphokine	Rare	Many
11. Macrophage	Rare	Many
12. Eosinophil	40-300	200

The immunogens are divided into two groups, those that will attack foreign objects immediately and those that will attack after some delay.

SECTION 3: POTENTIAL ATTACKING MICRO-ORGANISMS

While the sub will normally be attacked by the body's own immunogens, you also might encounter a transient micro-organism in the body. Any significant infections will have been destroyed before your mission begins, but at any time, in any body, there may be a small number of individual bacteria, viruses, parasites, or fungii in the blood stream. Some of these occur naturally in the body, such as Escherichia coli which inhabits the intestines and aids in digestion. Others may occur normally on the skin such as Staphylococcus epidermidis. The latter can enter the blood system through open wounds such as our patient has.

So, while you will not have to deal with any major infections, you may encounter isolated individual micro-organisms such as those listed in the table below. Details about these micro-organisms, their appearance, and the appropriate treatments for each can be found in your ship's on-board library. For STUDENT and PHYSICIAN players (See Table 1 of the General Instructions), the library will not provide appropriate treatment; refer to Table 3.

SECTION 4: EMERGENCY CONDITIONS

The patient you will be treating has experienced severe trauma with a possibility of some brain damage. At any time during the operation, the patient may experience a medical emergency which would require immediate treatment. A list of possible emergencies, their descriptions, symptoms, treatments, and effects if not treated properly or timely are listed below.

TABLE 2
INFECTIONS

BACTERIA	PARASITE	VIRUS	FUNGUS
3. Staph. aureus	29. Ent. histolytica	45. Enterovirus	61. Candida albicans
4. Staph. epidermidis	30. Balantidium coli	46. Coxsackie A virus	62. Histoplasmosis
5. Strep. pneumonia	31. Giardia lamblia	47. Picornavirus	63. Coccidiodes immitus
6. Escherichia coli	32. Plasmodium malariae	48. Paramyxovirus	64. Blastomycoses
7. Shigella	33. Toxoplasmosis gondii	49. Herpes zoster	65. Cryptococcus
8. Salmonelli	34. Enterobius vermic.	50. Herpes simplex	66. Actinomyces
9. Proteus	35. Trichuris trichura	51. Cytomegalovirus	67. Locardia
10. Serratia marescens	36. Ascariasis	52. DNA tumor virus	68. Aspergillus
11. Strep. veridans	37. Syphilus	53. ECHO	69. Geotrichum
22. Klebsiella	38. Trichinella spiralis	54. Epstein Barr virus	70. Sporothrix
23. Hemophilus influenza	39. Tinea saginatum	55. Coxsackie B	71. Streptomyces madurae
24. Enterococcus	40. Tinea solium	56. Rhinovirus	72. Paracoccidioides
25. Bacteroides fragilis	41. Strongyloides sterc.	57. Syneztial virus	73. Fonsecaea pedrosoi
26. Clostridium	42. Trichomonas	58. Parainfluenza virus	74. Phialopphora
27. Strep. pyogeses	43. Ancylostoma duoden.	59. Adenovirus	75. Mucormycosis
28. Neisseria gonorrhea	44. Lecator americanus	60. Hepatitis B virus	76. Allescheria boydii

TABLE 3
MEDICAL SUPPLIES AND ATTACKERS THEY ARE EFFECTIVE AGAINST

INVENTORY NUMBER	NAME	ATTACKERS
6.	X-RAY MACHINE	1, 2, 3, 6, 7, 12
7.	ANTIHISTAMINE	5, 12
8.	CORTICOSTEROID	9, 10, 11, 33
9.	DESENSITIZER	5
10.	ANTILYMPH. SERUM	8, 9, 10
11.	CHEMOTHERAPY	6, 8, 11, 35, 38, 39, 40, 52
12.	INTERFERON	4, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59
13.	GAMMAGLOBULIN	45, 46, 47, 48, 49, 50, 51, 53 54, 55, 56, 57, 58, 59
14.	ACYCLOVIR	49, 50, 51, 54
15.	HEPTAVAX-B	60
16.	PENICILLIN	12, 15, 21, 23, 24, 25, 26, 27, 28, 37, 66
17.	GENTAMICIN	14, 19, 20, 22, 25
18.	CEPHALOSPORIN	13, 14, 15, 16, 19, 21, 22, 26
19.	CHLORAMPHENICOL	18, 20, 22, 23, 24, 25
20.	TETRACYCLINE	13, 15, 16, 17, 26, 27, 28, 30, 66
21.	AMPICILLIN	16, 17, 18, 19, 21, 23, 24, 28, 67
22.	METHICILLIN	13, 14
23.	CHLOROQUINE	29, 32
24.	FLAGYL	29, 30, 31, 42
25.	QUINICRINE	38, 39, 40, 43, 44
26.	DARAPRIM/SULFA	33
27.	THIAMBENDAZOLE	34, 35, 36, 41
28.	PIPERAZINE	34, 36
29.	AMPHOTERICIN	61, 62, 63, 64, 65, 68, 69, 70, 71, 72, 73, 74, 75, 76

NOTE: Attacker Numbers 1-12 are immunogens.
Refer to Table 1.
Attacker Numbers 13-76 are micro-organisms.
Refer to Table 2.

TABLE 4
EMERGENCY CONDITIONS

EMERGENCY CONDITION	DESCRIPTION	SYMPTOM	TREATMENT	RESULT IF NOT TREATED
LOCAL HEMORRHAGE	Break in a blood vessel wall allowing loss of blood to surrounding tissues	Blood Pressure Falls Pulse increases	Gelfoam IV Fluids Vasopressin	Shock
GENERAL HEMORRHAGE		Blood Pressure Falls Pulse Increases	IV Fluids Vasopressin	Shock
SHOCK	Inadequate perfusion of tissues (most commonly due to loss of blood)	Blood Pressure Falls Pulse Increases	IV Fluids Isoproteronol	Cardiac Arrest
MALIGNANT HYPERTENSION	Rapid, high elevation of blood pressure	Increasing Blood Pressure and Pulse	Diazoxide	Death from Cerebral Hemorrhage
PULMONARY EDEMA	Inadequate pumping action of heart resulting in fluid overload and congestion of tissues	Increasing Blood Pressure and Pulse	Digoxin and Lasix	Atrial Arrhythmia

TABLE 4
EMERGENCY CONDITIONS
Continued

ATRIAL ARRHYTHMIA	Irregular heart beat due to Atrial fibrillation	Increasing Blood Pressure and Pulse	Digoxin	Cardiac Arrest
VENTRICAL ARRHYTHMIA	Irregular heart beat due to Ventricular Ectopy	Increasing Blood Pressure and Pulse	Lidocaine	Cardiac Arrest
SEIZURE	Violent muscular contractions or convulsions	Increasing Blood Pressure and Pulse	Valium	Seizure. Submarine damage or entrapment
CARDIAC ARREST	Heart stops beating	No pulse No blood pressure	Defibrillator followed by Epinephrine Bicarbonate Lidocaine	Death due to cessation of blood circulation

SECTION 5: PRE-EXISTING MEDICAL PROBLEMS

Completely independent of the recent trauma, your patient may have a number of other medical problems. These conditions may complicate your mission in a variety of ways. The primary medical conditions and their effects on your mission are listed below.

TABLE 5
PRE-EXISTING MEDICAL PROBLEMS

CONDITION	EFFECT ON MISSION
Alcoholic cirrhosis of the liver	-Fibrous tissue in liver blocks submarine passage to glucose stores. Use laser. -High immunogen levels. Low red cell level.
Viral hepatitis	-Very poor glucose stores (less fuel from liver hookup). -Heavy viral attacks in liver.
Emphysema (excessive cigarettes)	-Damaged lung tissue with copious secretions block sub's passage. Use laser.
Chronic Bronchitis (excessive cigarettes)	-Thickened lung tissue walls and mucous plugs block sub's passage. Use laser.
Myocardial infarction	-Arteriosclerotic plaque blocks sub's passage in arteries. -Higher incidence of pulmonary edema and atrial arrhythmia emergencies.

TABLE 5
PRE-EXISTING MEDICAL PROBLEMS Continued

Hypertensive heart disease	-Higher incidence of pulmonary edema, atrial arrhythmia, and ventricular arrhythmia. -Thickened heart walls may block passage somewhat.
Chronic renal failure on dialysis	-Scarred fibrotic tissue in kidney blocks passage to kidney hookup. Use laser. -Increased incidence of pulmonary edema and malignant hypertension.
Essential hypertension	-Vessel walls narrower. -Increased incidence of malignant hypertension.
Diabetes mellitus	-Arteriosclerotic plaques may inhibit passage of sub in arteries.

Hypercompetent Diseases
(higher than normal immunogen attacks)

Chronic myelogenous leukemia	High neutrophil level
Hodgkin's disease	High lymphocyte level
Infectious mononucleosis	High lymphocyte level
Juvenile rheumatoid arthritis	High neutrophil; high IgG
Chronic lymphocytic leukemia	High lymphocyte level
Benign Monoclonal gammopathy	High IgG or IgM level

Immunodeficiency Diseases (children)

Acquired hypogammaglubulinemia	No IgG; no IgM*
Selective IgM* deficiency	No IgM*
Selective IgG* deficiency	No IgG*
Nezelof's syndrome	No lymphocytes; decreased lymphokines
Complement deficiency	No complement
Drug induced immune neutropenia	Low neutrophil level

*See SECTION 2: Blood Samples for more information.