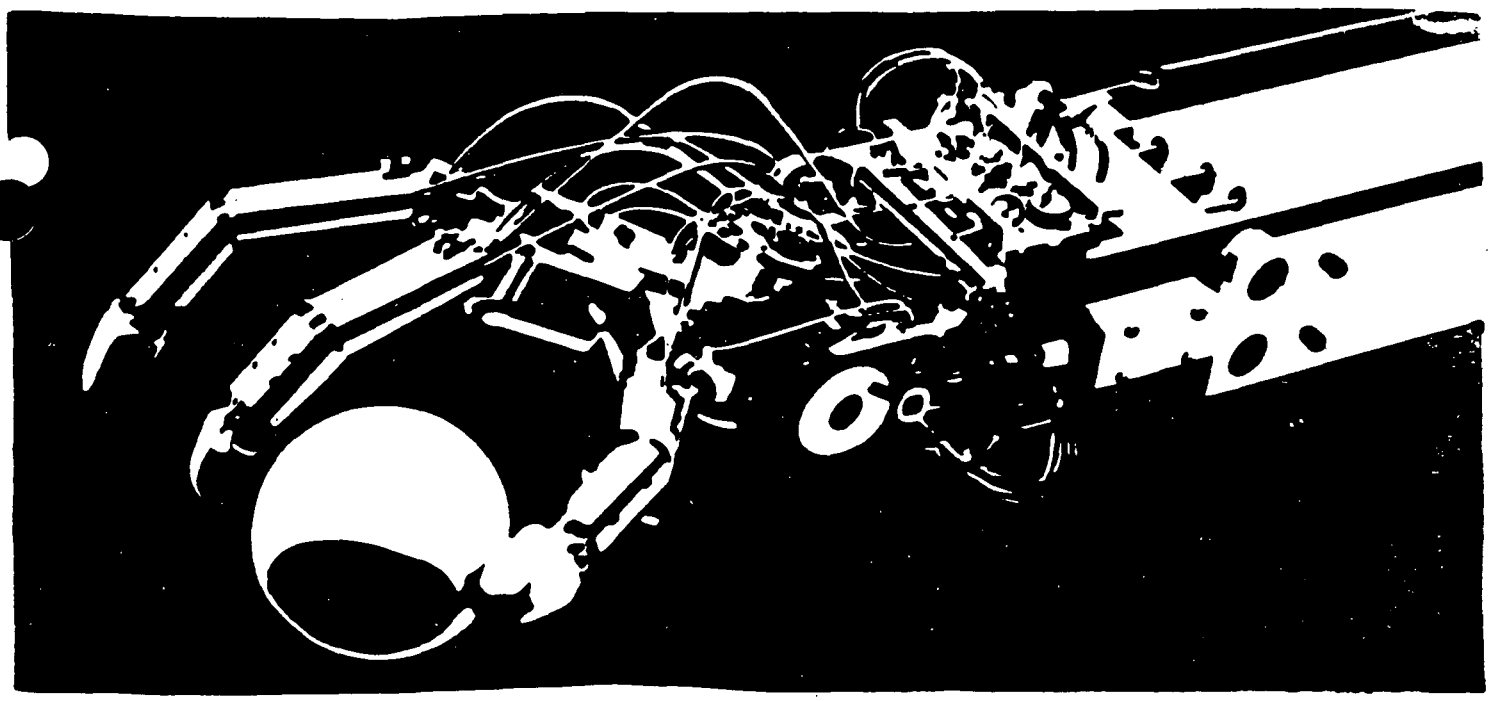
HEALTH OCCUPATIONS EDUCATION
TECHNOLOGY EDUCATION

BIOTECHNOLOGY
STUDENT ACTIVITY PACKAGES



The University of the State of New York
The State Education Department
Division of Occupational Education Programs
Albany, New York 12234

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FOREWORD

Biotechnology will prove to have as significant an impact on the lives of people in the several decades ahead, as mechanically based technologies had on those living in the early and mid 1900's.

Biotechnology, including bioprocessing and genetic engineering, will have applications to medicine and health care, agriculture and waste disposal. Related biotechnical innovations will humanize the relationship between people and technology through developments in human factors engineering (ergonomics). The growth of biotechnology will spawn new career opportunities for professional and paraprofessional personnel. In the area of health care, for example, new careers will transcend mere custodial care, and will include such diverse areas as bio-engineering improvement, prosthetic devices, and development of materials that are compatible with the human anatomy.

In an attempt to provide secondary school students with a basic understanding of biotechnology, its applications, and implications, a second annual symposium on biotechnology was held during the summer of 1988.

After hearing presentations on ergonomics, tissue culture, waste disposal, and human physiological monitoring, Health Occupations and Technology Education teacher-trainers worked cooperatively to develop student activity packages in each of these areas. Additionally, because the teacher-trainers participated in discussions relative to the ethical issues surrounding biotechnology research, it is hoped that a balanced view will be provided to other teachers and their students.

The attached set of biotechnology activities represent a collaborative attempt by teachers, industrialists and the Education Department to provide cutting-edge inservice education to New York State educators.

HUMAN PHYSIOLOGICAL MONITORING

INTRODUCTORY STATEMENT

The health industry is a major component of the entire service industry and indeed of the economy as a whole. As the employer of more than 7 million workers, including large numbers of minority and women workers, the health industry provides an exceptionally large number of jobs, many of them suitable for entry-level workers and recent graduates.

Powerful forces for expansion continue to act on the health industry. Pressures to increase the amount and quality of health care are likely to intensify in the years ahead because of the aging population and the rapid advancement of technology.

Using a systems approach to solve the problem of melding the health care industry with technology is one answer of viewing both the health industry and technology in a scientific manner and provides teachers in both disciplines a logical and practical approach of disseminating information.

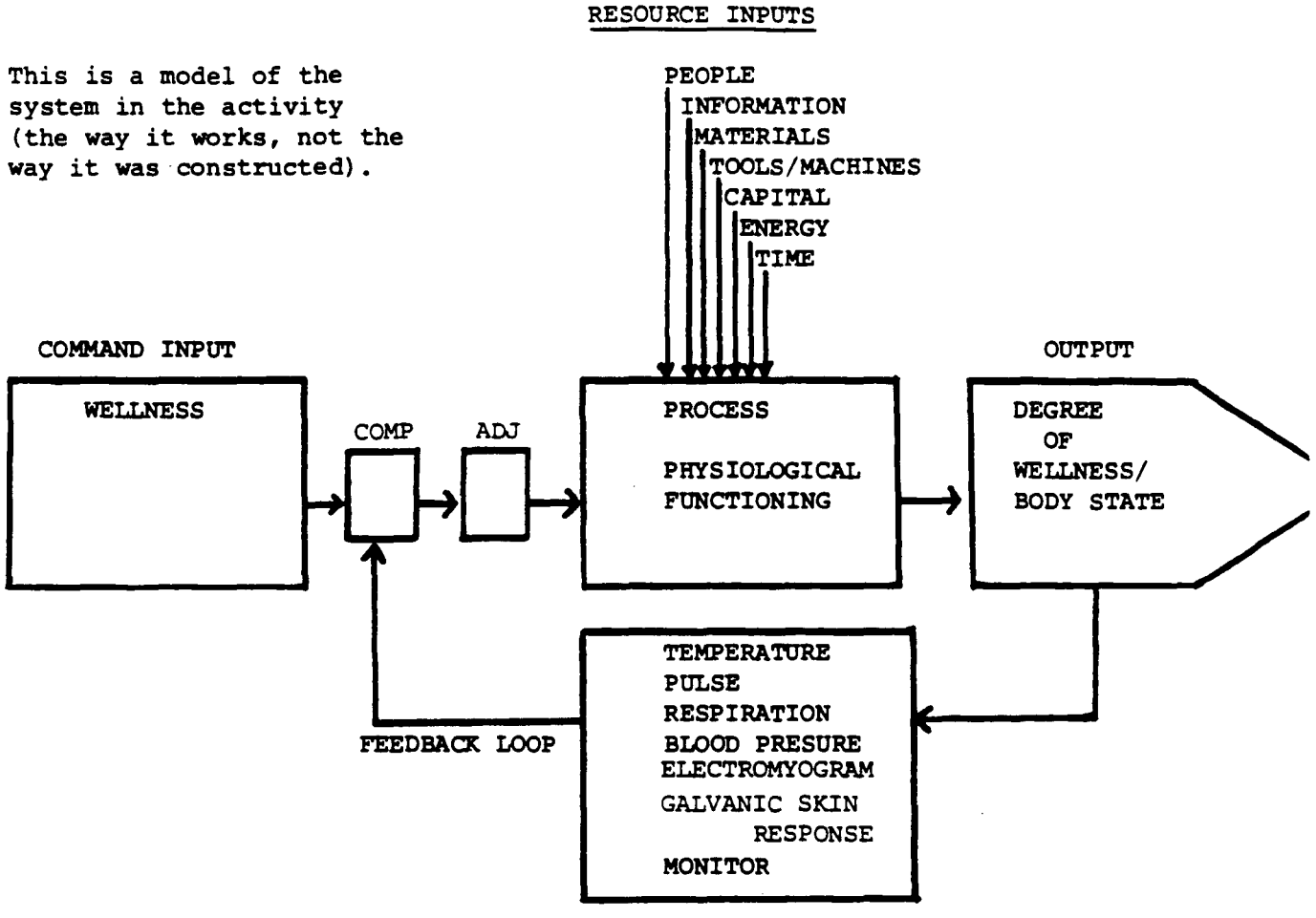
The goal of the following section is to provide techniques of monitoring specific bodily functions in traditional ways and also with new techniques from the technical arena. Monitoring these systems allows students to understand the physiological changes and adjustments constantly occurring in their bodies during everyday activities. By becoming aware of these body signal fluctuations, students can learn that they can control their bodies and also achieve optimum levels of wellness. It provides contact between the disciplines and a sense of security in working with technological advances.

Participants

Brian Hawkins
Richard Gifford
Wallace Yelverton
James Mooney
Terry Tremblay
Elaine Jones
Barbara Nunn
John Gagliardo

1) SYSTEM OF TECHNOLOGY

This is a model of the system in the activity (the way it works, not the way it was constructed).



LEARNING ACTIVITY BRIEF

Topic:

Human Physiological Monitoring: Temperature

SYLLABUS CONNECTION:

T - 8 Controlling Technological Systems

HOE CORE Mod - Overview of the Human Body

GOAL:

To understand the normal body temperature. To become aware of factors and activities that affect body temperature such as illness, stress and smoking. To become aware of the different technological advances used to monitor temperature.

OVERVIEW:

Body temperature reflects the general condition of wellness of the human body. In recent years, body temperature has been used as a modality for many health concerns including the effects of smoking and stress. Previously, an elevated temperature indicated illness. However, because of the lack of technology, mercury thermometers were the only tool available for measurement of body temperature.

Technology has changed all of this and now body temperature measurement is being used in research to determine the affects of smoking and as a biofeedback tool in reducing stress.

The temperature of a person's hand is directly related to stress. If a person is under stress, the peripheral blood vessels constrict forcing blood to the vital internal organs and brain. This mechanism has developed to place energy in the most important areas of the body so that the stressful event can be dealt with appropriately. Monitoring hand temperature and introducing relaxation exercises can assist people in recognizing and controlling the affects of stress on their bodies.

MATERIALS:

- liquid crystal card (available from Bodylog)
- watch/clock with second hand
- digital thermometers
- liquid crystal card thermometers
- mercury thermometer
- Bodylog - stress reduction package containing computerized temperature sensor, scientific and game software, extensive documentation on temperature measurement and stress reduction, and an audiotape of relaxation exercises.
- any TV monitor
- adult smoker with cigarette

DISCUSSION TOPICS:

1. Review anatomy and physiology of body temperature.

2. Discuss changes in body temperature relating to smoking. Explain that smoking raises the body temperature for approximately one hour after each cigarette, which causes all the body systems to work harder for that amount of time.

3. Discuss how stress causes blood to flow from hands and feet and transports it to vital organs where it is necessary for survival during the flight or fight syndrome.

4. Discuss daily situations that are stressful, e.g., taking tests, seeing a new boyfriend or girlfriend, being scolded by the teacher. Discuss that by monitoring the body's response to stress, namely decreased temperature, a program of stress management can be instituted.

ACTION PLAN:

1. Provide students with different types of thermometers for identification: mercury, crystal, electronic.

2. Place electronic thermometer probe in back of mouth, to the side under the tongue, and read results as equipment shows it.

3. Take temperature of an adult smoker. Have adult smoke cigarette. Immediately take temperature again and repeat at 10 minute intervals until body temperature returns to normal.

4. Place mercury thermometer in back of mouth to side of tongue and leave in place for three minutes. Read after wiping from end toward bulb.

5. Place card thermometer on forehead for length of time indicated in the directions included.

6. Using liquid crystal card, place thumb on specified area for 10 seconds and read results.

7. Use the Bodylog equipment to show student the consequences of stress on the body. Listen to the audiotape and raise hand temperature using the Peace of Mind Software and audiocassette tape of relaxation exercises.

LEARNING ACTIVITY BRIEF

TOPIC:

Human Physiological Monitoring: Heart Rate

SYLLABUS CONNECTIONS:

T - 8 Controlling Technological Systems

HOE CORE Mod - Overview of the Human Body

GOAL:

To understand the normal range of heart rate at rest. To become aware of factors and activities that affect heart rate such as exercise, stress, smoking, caffeine, and drugs. Learn how to improve the heart through exercise and relaxation.

OVERVIEW:

The heart is a living pump that is constantly circulating blood around the body. The blood picks up oxygen from the lungs and then carries the oxygen to the muscles and vital organs to act as fuel. When the vessels that carry the blood pass over bone near the surface of the skin, you can manually feel each pulse of the heart. When a person is resting, the heart does not need to supply much fuel to the body, so it beats slowly. The more work or exercise a person performs the more fuel is needed, so the heart beats faster. A person who is fit has a strong heart that pumps more blood with every beat, so their heart does not need to work as hard when sending fuel to the body. When a person is under stress, internal changes in the body cause the heart to beat faster. Through relaxation strategies a person can learn to control their heart rate in stressful situations.

MATERIALS:

- watch with second hand
- electronic heart rate sensor or Bodylog Heartlab package which includes computerized pulse rate sensor, laboratory style software, and lab tasks for monitoring and understanding the heart

DISCUSSION TOPICS:

1. Review the heart and circulation system.
2. Discuss heart rate at rest.
3. Discuss changes of heart rate with exercise. Explain how exercise, with time, increases the strength and efficiency of the heart, such that it does not have to work as much to keep functioning in daily life. Emphasize need for daily exercise. Fit to live.
4. Discuss daily situations that are stressful, e.g., taking tests, seeing a new boyfriend or girlfriend, being scolded by the teacher. Explain that these events cause heart rate to rise. Discuss how, by monitoring heart rate, a person can learn to not allow the body to become too upset as a consequence of stress.

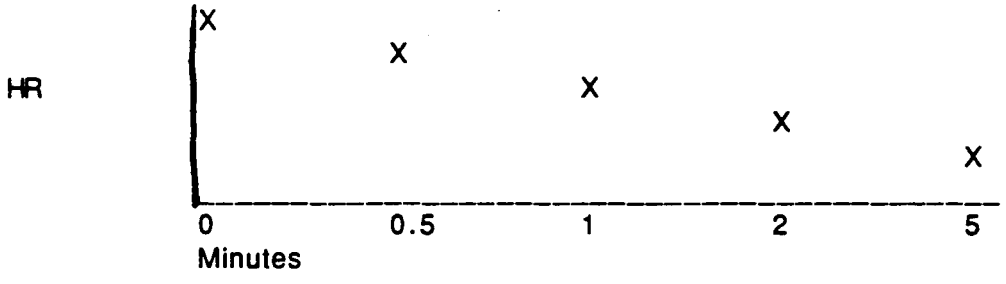
ACTION PLAN:

1. Use physiological diagrams to show heart and circulation system. Explain need for oxygen as fuel.

2. Take resting heart rate manually for whole class and plot on a chart. Find pulse sites either at thumb side of wrist or between jaw and windpipe on the neck. Have each student count their own pulse for 10 seconds and multiply the number by five to obtain beats per minute. Repeat five times. Discard the two highest and the two lowest numbers and use the one remaining as the student's heart rate. Plot the heart rate of the whole class on one graph to establish natural range of heart rates.

3. Use electronic measuring device and compare to manual readings.

4. Have one student exercise for one minute, e.g., step on and off a step as fast as possible. Using electronic pulse sensors, test heart rate immediately, 30 seconds, one minute, two minutes, and five minutes after the exercise stops. Plot on a graph:



5. Give two students a competitive mental task to do under pressure, e.g., count backwards from 100 but only with numbers divisible by three. Measure the heart rate of the students electronically as they compete to study the affect of stress on the heart.

6. Using relaxation techniques try to teach students how to stay calm during stress, then repeat the competition in number five, but have students attempt to keep heart rate down.

7. Monitor heart rate after students drink caffeinated drinks. Teach them about the affects of smoking and drugs.

8. Use Bodylog Heartlab step test to ascertain the fitness level of each student.

9. Use Bodylog Heartlab Hang phone to teach relaxation.

10. Use Bodylog Heartlab plotting to plot graph of each student's heart rate.

LEARNING ACTIVITY BRIEF

TOPIC:

Human Physiological Monitoring: Breathing

SYLLABUS CONNECTIONS:

T - 8 Controlling Technological Systems

HOE CORE Mod - Overview of the Human Body

GOAL:

To understand the respiratory system in regards to capacity, ability to measure, and how an individual has control of changes in his breathing habits.

OVERVIEW:

Knowing the operation of our respiratory system gives us some control over our breathing under stress conditions. It also suggests that we can learn, within limits, under what situations our breathing changes and techniques for reducing stress.

MATERIALS:

- Biology Series and Software material from IBM, "Human Life Processes II: System Level"
- graphic representation of respiratory system
- balloons, tape measures
- Bodylog, Inc. Software, manuals
- "Breath Volume Kit" Science Kit. Boreal Laboratories, Tonawanda, NY 14150
- two small water containers (one must fit inside the other), air tube, PVC pipe

DISCUSSION TOPICS:

1. Respiratory system -- its function and operations. Review and describe.

2. Capacity of lungs -- breathing rate. Using monitoring devices, measure volume and rate of breathing.

3. Discuss stress and how it is reflected in the respiratory system. Emphasize that individuals can have control of a rapid change in their breathing by knowing what is happening and what can be done about it.

ACTION PLAN:

1. Provide students with graphic representation of the respiratory system. Graph will identify function of system. Students will label parts on graphic presented. (Biology Series and Software from IBM "Human Life Processes II: Systems Level" can be of value.)

2. Students will be given balloons to blow up. The balloons can explain breathing and its mechanics, and also the various capacity of the lungs of different students.

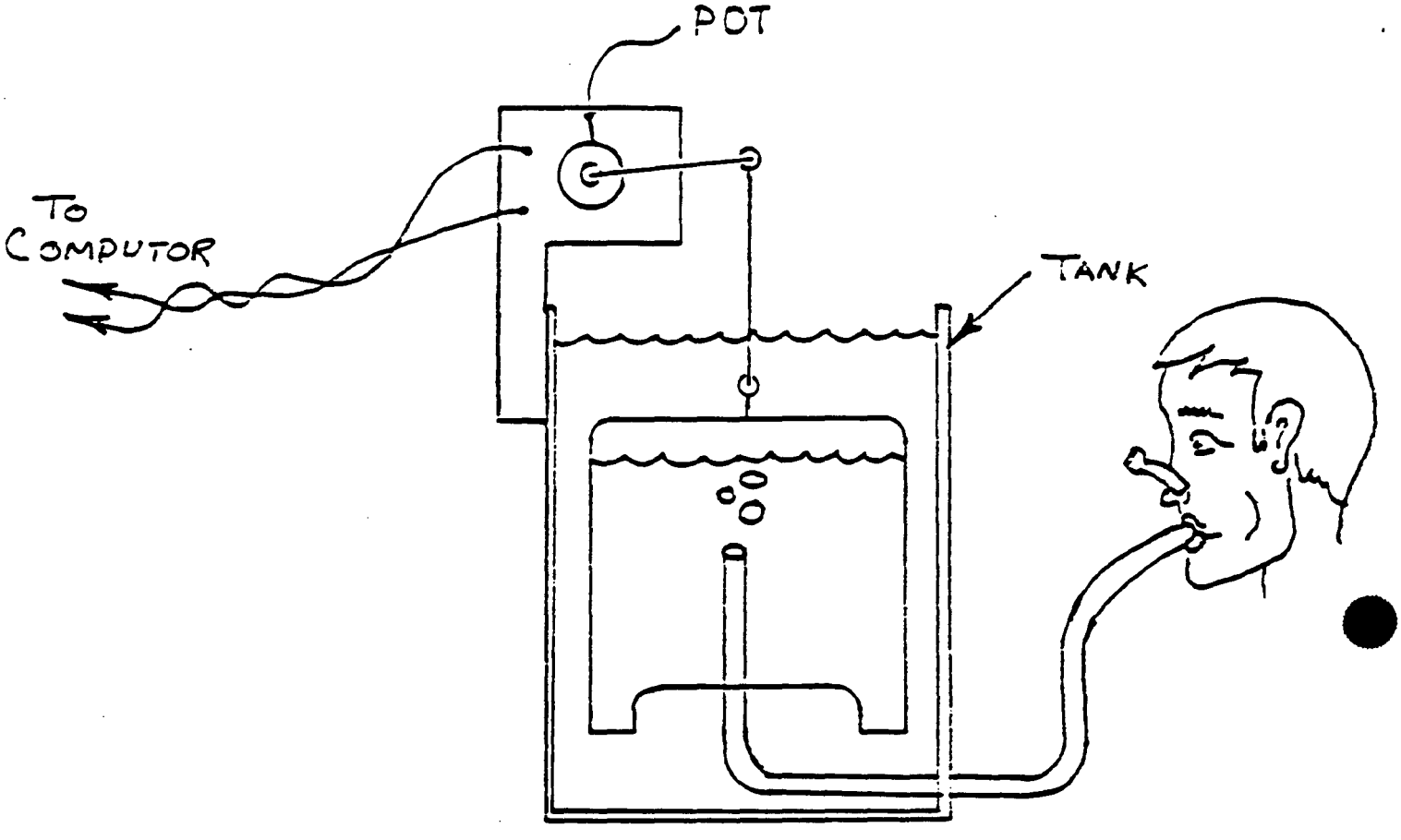
3. Using a tape measure, have paired students measure expanded lungs and exhalation. Some will have greater capacity than others. Record measurement between exhaling and inhaling.

4. With a tank, a small contains of water with a second container invested in first tank and air hose connect, have students force water out of inverted containers. Students will work in pairs. Record the height the student can raise the inverted container by exhaling (blowing) into the tube. (See diagram of system for measuring breathing volume.)

5. Measure the amount of air normally taken in a single breath using the "Breath Volume Kit." (Science Kit and Boreal Laboratories Catalog, Tonawanda, NY 14150). Pair up students and have each record the amount of air a person breathes in one minute. (One or two kits may be enough because mouth pieces can be reproduced from PVC pipe.)

6. Have students understand how one can control his breathing by using the measuring devices found in Bodylog equipment. Give each pair of students the opportunity to see graphically (electronic graphs) their breathing pattern. Introduce emotions by touching or referring to spoken word that elicits emotions, such as, "a test will be given," "oral report is due tomorrow," etc. Have students note changes in electronics of their breathing on the screen (monitor using Bodylog equipment). Explain to students how they can control their breathing. See if they can test their ability to relax when they note stress is reflected in their breathing as shown on the monitor.

7. Conclude by identifying a situation that causes us to increase our breathing, such as stress, exerting ourself, danger, upset, etc. Also, indicate how we can learn to control our breathing.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TO
COMPUTOR
TANK

LEARNING ACTIVITY BRIEF

TOPIC:

Human Physiological Monitoring: Blood Pressure

SYLLABUS CONNECTIONS:

T - 8 Controlling Technological Systems

HOE CORE Mod - Overview of the Human Body

GOAL:

To understand what is being measured when taking blood pressure. To understand the normal range given a specific blood pressure. To understand factors affecting blood pressure such as age, size, conditioning and emotions.

OVERVIEW:

Because of the vital importance of the heart working as an efficient pump, the measurement of the blood pressure is an extremely helpful tool used to determine that efficiency. When performed correctly, the blood pressure measurement tells the operator the pressure of the blood circulating in blood vessels when the heart contracts (beats) and relaxes (rests).

The nervous system is responsible for regulating the beats, and the muscular condition of the heart is responsible for the force of the contraction of the beat. Fitness counts -- the better condition the heart muscle is in, the more collateral circulation; the more efficient the contraction, more blood is pushed out of the heart with each beat.

Size is an important consideration when measuring blood pressure. A large person has more blood vessels so the heart has to push the blood further along and the contraction has to be more forceful to do so. Emotions also affect blood pressure: excitement raises blood pressure, depression lowers blood pressure. Relaxation techniques can also be used to lower response. The American Heart Association mentions Benson's Relaxation response as a very useful tool for the purpose of lowering blood pressure.

New technology for taking your own blood pressure is available, the cuffs and stethoscopes are on sale for the general public. Be very careful when using electronic measuring devices, these machines can be inaccurate.

MATERIALS:

- blood pressure cuff with sphygmomanometer and stethoscope.

DISCUSSION TOPICS:

1. Discuss the affects of emotions upon blood pressure.
2. Discuss the affects of exercise and/or conditioning on blood pressure.
3. Discuss what happens to blood pressure with the relaxation response.

ACTION PLAN:

1. Review the anatomy and physiology of the heart, arteries and veins.

2. Define systolic and diastolic blood pressure.

3. Measure pressure within the blood vessels by taking arterial blood pressure.

LEARNING ACTIVITY BRIEF

TOPIC:

Human Physiological Monitoring: Electromyograms (EMG)

SYLLABUS CONNECTIONS:

T - 8 Controlling Technology Systems

HOE CORE Mod - Overview of the Human Body

GOAL:

To understand that all voluntary human movement is caused by muscle contractions. The voluntary muscle contractions are caused by electrical signals that are conducted from the brain via the nervous system. To understand which muscles are responsible for simple arm movements. To understand that stress is often accompanied by muscle tension, which can be relieved via EMG biofeedback. To understand that EMG monitoring can be used to help muscle rehabilitation of certain injuries and paralysis.

OVERVIEW:

Voluntary muscle contractions are caused by tiny electrical signals from the brain. These signals can be monitored using electrodes, and then amplifying them. The signals are called electromyograms (EMG). The contractions of the muscles cause the movement of the bones that the muscles are attached to and, consequently, this causes limb or body movement. By placing the EMG electrodes in various sites on the body it can be determined which muscles are responsible for which types of limb and body movement. A major area for use of EMG monitoring is in physical therapy, and in pain management. Patients who have had accidents that cause range of motion problems can be analyzed by using the amount of electrical activity in muscles as a guage for muscle strength. Back pain is often caused by muscles that are contracting involuntarily and are pulling on the back in different directions. Through biofeedback of EMG, patients can be taught where they have assymetrical tension and subsequently they can learn to relax the muscles and relieve the pain. Stress can also cause involuntary contraction and tension in muscles. Through EMG feedback everyone can learn to relax muscles and reduce the pain and discomfort associated with tense muscles.

MATERIALS:

- EMG sensor or Bodylog Enhanced Stress Reduction package which contains two EMG sensors, scientific and game software, literature relating to EMG monitoring and stress reduction, an audiocassette tape of relaxation exercises and a temperature sensor (see temperature monitoring).

DISCUSSION TOPICS:

1. Explain that limb movement is caused by muscles that act like springs drawing two bones together across a joint.

2. Talk about neural commands that travel through the nervous system, cause muscles to contract, and create movement.

3. Discuss what happens when a muscle is contracting but no movement is occurring, i.e., pain and tension.

4. Discuss how showing a person where muscle tension is occurring in the body using EMG sensors can help the person identify the source of their pain and subsequently learn to relieve the tension.

5. Discuss how stroke patients cannot send signals to muscles or feel their muscles. Through EMG techniques the patient can be shown the tiny signals that they are trying to send to their muscles and over time the patient can be helped to regain the use of their muscles and limbs.

ACTION PLAN:

1. Show the muscle system on physiological charts or diagrams.

2. Select the biceps muscle and the triceps muscle and use EMG sensors to show how the two muscles operate together to cause the forearm to move back and forth.

3. Use the sensors on other parts of the body and determine which muscles are responsible for common movements such as bending, kicking, walking and throwing.

4. Place EMG sensors on the forehead (frontalis muscles) and monitor the tension while two students perform mathematical problems under competitive conditions, e.g., give 10 math problems that they have to answer on paper and see who can answer them the fastest. This should demonstrate how tension occurs as a result of stress.

5. Teach students to relax forehead muscles then retake a similar competitive test while attempting to keep relaxed. If students can always be aware of inappropriate tension, they may be able to reduce the negative consequences of stress on their bodies.

6. Simulate what happens when a person has an accident that prevents joint motion by holding a student's arm on the arm of a chair. Explain that if a muscle is not used it begins to atrophy, e.g., after it has been in a cast. Then, using EMG sensors, show how the patient can keep the electrical signals working so that atrophy does not occur. If you have the Bodylog EMG equipment, show how EMGs can be used to play video games and keep patients motivated to exercise their muscles.

LEARNING ACTIVITY BRIEF

TOPIC:

Human Physiological Monitoring: Galvanic Skin Response (GSR)

SYLLABUS CONNECTIONS:

T - 8 Controlling Technology Systems

HOE CORE Mod - Overview of the Human Body

GOAL:

To understand that perspiring is a natural, constantly occurring response that can be measured electronically. Students will become aware that hand perspiration increases measurably in response to stress, emotional states and when a person tells lies. Students will learn that monitoring hand perspiration can be used to help them learn how to control their response to stress.

OVERVIEW

Galvanic skin response is the electronically measurable increase in skin conductance that occurs when a person sweats. There is always some level of sweating, but this level changes constantly as a function of daily events such as changes in stress, emotional changes, exciting thoughts, upsetting thoughts, and physical contact. GSR is the main ingredient used in lie detector tests. The changes in GSR are immediate, are extremely interesting, and fun for students to experiment with.

MATERIALS:

- GSR sensor or Bodylog's computerized GSR sensor, scientific and game software, and documentation.

DISCUSSION TOPICS:

1. Sweating is natural and occurs constantly.

2. As a person sweats, the skin conductance increases and this can be measured electronically via GSR.

3. Even small changes in a person's emotional state will cause GSR to increase dramatically.

4. When a person tells lies, the internal moral struggle can cause GSR to increase.

5. Psychologists use GSR to help people learn what types of things affect them emotionally. They also can help a person to reduce fear of certain things, e.g., flying, by teaching the person to control their emotional responses by inhibiting GSR changes.

ACTION PLAN:

1. Monitor a student's GSR. Touch the student's face, then watch the GSR change. How long does it take before it changes?

2. Ask the student to sing to the rest of the class. The anticipation will cause GSR to change. The student will not actually have to start singing.

3. Bring a worm or some other noxious object close to a student and monitor GSR.

4. Try to teach student to not respond emotionally when the noxious object comes close. Through the feedback of the GSR, reduce the student's response to the noxious object. Explain that this is the way people can be helped to deal with unreasonable fears.

5. Use Bodylog's audiocassette tape to reduce stress and GSR through relaxation exercises.

6. Measure GSR levels of entire class and note changes in GSR in response to touching the face of everyone. Plot graphs and show that some people respond much more than others. Bodylog equipment will automatically plot graphs for you.

TERMINOLOGY

1. anatomy
2. biotechnology
3. blood pressure
4. circulation
5. conductor
6. digital equipment
7. electrode
8. hardware
9. muscle tone
10. nervous
11. physiology
12. pulse
13. relaxation
14. respiration
15. sensor
16. software
17. stress
18. system
19. temperature
20. vessels
21. systolic
22. diastolic
23. stethoscope
24. galvanic skin response

ABBREVIATIONS

1. B. P.
2. C
3. EMG
4. F
5. Hg
6. mm
7. TPR

CAREER INFORMATION SHEET

Career Title:

Biotechnical Specialist

Description of Career Responsibilites

The health sciences are concerned with the prevention, maintenance and rehabilitation of human life. The following is a list of career titles which utilize skills from Health Occupations and Technology:

Representative Career Titles:

Registered nurse
Practical nurse
Nursing assistant
Home health aid
Rehabilitation aid
Respiratory therapist
Respiratory aid
Physical therapist
Physical therapy aid
Occupational therapist
Occupational therapy aid
Radiology technician
EKG technician
Sonographer
EEG technician
EMT
Pharmacist
Pharmacy aid
Dental/Medical assistant
Nuclear medicine specialist
Animal handler
Dietician
Dietary aid
Chiropodist
Podiatrist
Prosthetic designer (prosthetist)
Industrial engineer
Computer programmer
Optician
Dental/prosthetic designer
Epidemiology aid
Lab technician
Medical doctor
Teacher
Salesperson

Educational Requirements

High school preparation includes: biology, chemistry, physics, vocational specialty, technology, computer applications.

Skills or Personal Attributes Needed

1. Sense of commitment and dedication
2. A well - rounded personality
3. Adequate eye/hand coordination
4. Ability to communicate orally and by written word to others
5. Caring about others

Salary Level

Entry-level careers in the biotechnological field begin at just above minimum wage and extend to over $100,000 depending on educational preparation and perceived need.

Employment Opportunities

The health industry is expected to continue to expand throughout the 1990s and maintain its leadership in the economic market.

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RESOURCES:

Bodylog Inc. - 34 Maple Avenue, Armonk, NY 10504
Inside NY (914) 273-6480
Outside NY (800) 233-2911

Human Physiological Monitoring Package which includes computerized pulse, temperature, EMG, Force, and GSR sensors with easy to operate scientific, game, and applications software. Extensive documentation and step by step guides instruct teachers and students in the methodology of human physiological monitoring. Individual sensors, software, and manuals are also available.

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Sunburst Communications, 39 Washington Avenue, Pleasantville, NY 10570 - "The Human Pump".

American Heart Association and American Lung Association filmstrip on heart blood vessels and lungs; speakers on monitoring devices.

Career Aids filmstrips, 20417 Nordhoff Street, Dept. N3, Chatsworth, CA 91311 - Human Body Systems.

Trainex Corp. P.O. Box 116, Garden Grove, CA 92642 - Temperatures, Pulse, Respirations, Blood Pressure.

American Physical Therapy Association (APTA), 1111 North Fairfax Street, Alexandria, VA. 22314, (703) 684-APTA.

Biofeedback Society of America (BSA), 10200 West 44th Avenue #304, Wheat Ridge, CO 8003-2840.

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HUMAN PHYSIOLOGICAL MONITORING

Suggested Test Questions:

1. Pulse and heart rate are the same
   (T)

2. Select the choice that does not effect pulse:

   a) Smoking
   b) Overweight
   *c) Television
   d) Exercise

3. The heart rate can be measured on one place of the human body.
   (F)

4. Everyone's heart rate or pulse is the same.
   (F)

5. You measure your pulse with your thumb.
   (F)

6. The earlobe monitor reads heart rate by:

   *a) Infrared transmitter and detector
   b) Pulse meter
   c) Pressure sensitive switch
   d) Thermistor

7. EMG is the abbreviation for Electromyogram.
   (T)

8. Where is the heart located in the body?

   *a) Left side of chest
   b) Under breast bone
   c) Right side of chest
   d) Mid-abdomen

9. The number one cause of death in the United States is:

   a) Cancer
   b) Heart disease
   *c) Accidents
   d) Diabetes

10. The type of sensor used to monitor heart rate from the earlobe is:

a) Moisture
*b) Photo
c) Heat
d) Chemical

Blood Pressure Test Questions:

1. Blood pressure measures heart beat.
(F)

2. A stethoscope is necessary to take blood pressure.
(T)

3. How many numbers do you need to record a blood pressure?

a) One
b) Two
c) Three
*d) Four

4. What is blood pressure?

a) Heart beat
b) Pulse taken at tip of heart
c) Contractions of heart
*d) Force of blood flow

5. The only person qualified to evaluate your blood pressure is:

a) Athletic trainer
b) School nurse
*c) Family doctor
d) Exercise therapist

6. One breath in and one breath out is called a _____.
(respiration)

7. The purpose of respiration is to supply the body with

a) carbon dioxide
*b) oxygen
c) nitrogen
d) smoke

8. You can lower your respiratory rate.
(T)

9. You can increase your lung capacity with exercise.
(T)

10. In a fight or flight situation, our emotions change our physiological functions in the following ways:

a) increase heart rate, temperature and blood pressure
b) decrease heart rate, temperature and blood pressure
c) decrease hand temperature, respirations
*d) increase blood pressure, respirations and pulse

11. Body temperature can be measured on the forehead.
(T)

12. The purpose of measuring body temperature is to indicate change of body functions.
(T)

13. Electronic measuring devices may be more accurate than previously used measuring devices.
(F)

14. Galvanic skin monitoring can indicate a person at a high level of stress.
(F)

15. EMG measures

*a) temperature
b) blood pressure
c) muscle activity
d) respiration

16. Stress can be controlled by relaxation techniques.
(T)

ERGONOMICS: THE SCIENCE OF HUMAN FACTORS ENGINEERING

INTRODUCTORY STATEMENT

During the past century we have moved through three stages of technological advance: mechanization, automation, and computerization. During that same time, however, people have really not changed very much. We still play and work, love and war, learn and err, live and die. Yet the ways in which we do all of these things has been changed radically by technology.

Science and technology have continued to provide us with artifacts which improve our lives, making them easier, longer, and more enjoyable. Yet these same artifacts have, likewise, made our lives more complex, more difficult, and more frustrating. This seems to be the never ending price we pay for our affair with artifacts. The cost of function is frustration. This is the paradox of technology. Human factors engineering, or ergonomics, is the profession which attempts to shape these artifacts into products and places which are both usable and enjoyable.

The goal of the following section is to provide background information on how product design influences usability. Analytic and synthetic aspects of human factors engineering will be addressed. The problem solving method will be used to provide students with the opportunity to solve a design problem.

<u>Participants</u>

Joan Boorman
Robert Jones
Carolyn Kozubal
Carolyn Flynn
Vito Tisci
Stuart Soma
Dr. James Wilson

LEARNING ACTIVITY BRIEF

Ergonomics: The Science of Human Factors Engineering

SYLLABUS CONNECTIONS:

T-1 Getting to Know Technology
T-3 How People Use Technology to Solve Problems
T-5 How Technology Affects People and the Environment

HOE CORE Mod - Maintaining and Promoting a Safe Environment
Mod - Overview of the Human Body
Mod - Introduction to Health Careers

GOAL:

To understand the science of human factors engineering and its impact on our daily lives.

OVERVIEW:

Ergonomics is the science of designing products and places to serve the needs of the people who will use them. Ergonomics, also called human factors engineering, combines the findings of many fields, including studies of human measurement, muscle movement, and vision, with the techniques of design and engineering.

MATERIALS:

This brief may be executed using tools as simple as tape measures or as complex as goniometers. Creativity of the teacher is the only limiting factor.

DISCUSSION TOPICS:

1. An explanation of the science of ergonomics; its method of problem solving, its tools and techniques and its applications.

    a. humanizing the office
    b. creating clear visual messages
    c. factors in transportation
    d. designing for the consumer

2. An explanation of the special needs and limits of people with handicapping conditions, with attention toward designing appropriate technological aids and devices.

ACTION PLAN:

1. Introduce students to the topic of ergonomics, possibly through use of discovery learning or audio visual presentations.

2. Analyze physical characteristics (measure and record "average" sizes of humans).

3. Review skeletal and muscle systems (Body Works on the MacIntosh computer).

4. Introduce a method of problem solving used in human factors engineering.

5. Have students apply problem-solving method to an actual life situation.

GOING BEYOND:

1. Have students simulate handicapping conditions and attempt to function normally. Debrief students and brainstorm for technological solutions.

2. Choose appropriate audio-visual materials.

   (see bibliography and other resources)

3. Invite ergonomic specialists to discuss their professions, i.e., Fischer-Price or Eastman-Kodak Co.

4. Create a checklist for evaluation of a product (i.e., toys, telephone, car) using appropriate consumer safety guides, then evaluate typical products against the checklist.

DAILY LESSON PLAN

Topic

An Introduction to Ergonomics/Human Factors Engineering

Syllabus Connections

T-1 Getting to Know Technology
T-3 How People Use Technology to Solve Problems
T-5 How Technology Affects People and the Environment

HOECORE Mod - Introduction of Health Careers
Mod - Overview of the Human Body
Mod - Maintaining and Promoting a Safe Environment

Setting the Stage

To gain a knowledge of how design of products and places influences use.

Performance Objective

The student will be able to:

1. Define ergonomics
2. Explain application of ergonomics by example

Strategies

1. Critique the design of selected product(s)
2. Compare a poorly designed item to a well designed item

Summary Questions

1. What is ergonomics?
2. Why is there a need for human factors engineering?
3. Who benefits from a well designed product?

Assignments (Homework)

Measure the seat height of six different chairs; record data and retain for use in Lesson II.

Materials Needed

Will very with activity selected - to be left to discretion of instructor.

DAILY LESSON PLAN

Topic

The Importance of Ergonomics/Human Factors

Syllabus Connections

T-1 Getting to Know Technology
T-3 How People Use Technology to Solve Problems
T-5 How Technology Affects People and the Environment

HOECORE Mod - Introduction of Health Careers
Mod - Overview of the Human Body
Mod - Maintaining and Promoting a Safe Environment

Setting the Stage

To gain an understanding of how design influences usability. The application of human factors engineering to improve the design, making it compatible with human capabilities and limitations.

Performance Objective

1. Identify needs resulting from individual differences.
2. Identify factors of human use involving safety, comfort, and usability.
3. Distinguish between product function and usability.

Strategies

1. Measure some physical attributes of students.
2. Determine "average" of attributes measured. Discuss how virtually each student is not average in all ways.
3. Use measurements as basic data for activity selected by instructor. (Refer to assignment in Lesson 1.)

Summary Questions

1. Why do needs differ among individuals?
2. What factors influence safety, comfort, and usability?
3. Explain by example the difference between function and usability.

Assignments (Homework)

1. Measure toilet seat (width, length, height from floor). Write paragraph telling how you feel sizes were determined.
2. Make a list of items in classroom that impact your safety, comfort, and usability.
3. Measure heights of tables and desks and compare this data with the heights of chairs, which was collected in previous lesson.

Materials Needed

- As determined by teacher, suited to activity.

DAILY LESSON PLAN

Topic

How Human Factors Engineers Solve Problems

Syllabus Connections

T-1 Getting to Know Technology
T-3 How People Use Technology to Solve Problems
T-5 How Technology Affects People and the Environment

HOECORE Mod - Introduction of Health Careers
Mod - Overview of the Human Body
Mod - Maintaining and Promoting a Safe Environment

Setting the Stage

To gain an understanding of how human factors engineers analyze, design and evaluate products and places.

Performance Objective

The student will be able to:

1. List steps of analysis, design, and evaluation.
2. Analyze the degree to which design fulfills both function and usability.
3. Discuss methods used to evaluate products by human factors engineers

Strategies

1. Design a car (computer software such as "Car Works" might be used for this)
2. Design and build a model car appropriate to a human silhouette
3. Design a "helping tool" for a disabled person, i.e., for an arthritis sufferer.

Summary Questions

1. How do human factors engineers solve problems? List steps.
2. How would you analyze a product using the methods of human factors engineering?
3. Define these terms as they relate to the human factors engineering; analyze, design, and evaluate human factors engineering.

Assignments (Homework)

How would a human factors engineer design a light switch? (Parameters to be established by instructor). Write a paragraph.

Materials Needed

To be determined by instructor as appropriate to activity.

DAILY LESSON PLAN

For use in Health Occupations

Topic

Student Applications of the Ergonomic Problem Solving Model

Syllabus Connections

T-1 Getting to Know Technology
T-3 How People Use Technology to Solve Problems
T-5 How Technology Affects People and the Environment

HOECORE Mod - Introduction of Health Courses
Mod - Maintaining and Promoting a Safe Environment
Mod - Overview of the Human Body

Setting the Stage

The student will be able to apply the problem solving model.

Performance Objective

Sensitize students toward the special needs and limitations of handicapped persons through direct experience with products and places.

Strategies

1. Have some student volunteers spend the period blindfolded or using crutches.
2. Have the student volunteers describe their experiences and engage the class in a group discussion of other difficulties which the handicapped encounter; at home, shopping malls, recreational sites.
3. Remind the students of the problem solving model and ask each to consider an appropriate design for a particular site; i.e. home, school, office.
4. Have each student select a particular site and become a human factors engineer in the re-design of this environment to accommodate the special needs of handicapped citizens.

Structure of Lesson

1. Have the students analyze their problem through some of the following:

   a. Brainstorm lists of specific design problems which may be encountered by the blind, the elderly, the deaf (constraints) in their chosen sites.
   b. Research appropriate building codes and/or specification of equipment (criteria).
   c. Experiment with "being handicapped" in the chosen environment.
   d. Conduct an interview with a handicapped person or an advocate for the handicapped person.

2. Provide the students with scaled diagrams of rooms, chairs, stairs, cars, etc., which they may use to illustrate their own design.
3. Have each student create at least one design either using the diagrams provided or his/her own creation.
4. In small groups, have each student "sell" his/her design while being critiqued by peers
5. Ask each student to list and respond to the peer evaluation.
6. Have students make appropriate changes to their design and then submit final draft for the teacher's evaluation.

Summary Questions

1. What are the steps in the problem solving model?
2. Name two methods for analyzing a problem.
3. Describe one method for obtaining feedback when creating a design.

Assignments (Homework)

1. Fill in the blank copy of the problem solving model with the appropriate list of terms.
2. Make a list of agencies which act as advocates for persons with handicapping conditions.

DAILY LESSON PLAN

Topic

A Problem Solving Activity for Junior High Using Ergonomic Principles

Syllabus Connections

T-1 Getting to Know Technology
T-3 How People Use Technology to Solve Problems
T-5 How Technology Affects People and the Environment

HOECORE Mod - Introduction of Health Careers
Mod - Overview of the Human Body
Mod - Maintaining and Promoting a Safe Environment

Setting the Stage

To gain skills in using materials while applying the Problem Solving Method to an Ergonomic Design Problem.

Performance Objective

Students will be able to design and build a downhill "snowbox" racer given contest limitations, through scale model and full-size vehicles.

Strategies

1. Discuss the rules sheet provided by WGRZ-TV2 and Kissing Bridge Ski Resort for their annual "Snow Derby Downhill Racer". Show film/video clips of the action from past years races. (This is a local event near Buffalo, NY). Teachers in other locations would need to set their own rules for racing and vehicle design. The Problem: To design and build a downhill (gravity powered) snow racer that will cover a given downhill course in the quickest time. They will also be judged for uniqueness creativity, and compliance to limiting constraints.
2. Identify/set constraints:

    a. From offical rules sheet (contest).
    b. Set by class, e.g. discuss and arrive at consensus for material size and content.
    c. Define and set resource limits - (tool/materials).

3. Team: Discuss and evaluate individual designs, and identify the optimal alternatives for development.
4. Build and test full size solution model and monitor results of tests.
5. Select and modify alternatives to improve design.
6. Retest until optimal consensus is reached.
7. Compete with vehicle.
8. Analyze results of competition data to close out unit.

Summary Questions

1. What are the steps in the Problem Solving Model?
2. Describe what is meant by OPTIMUM.
3. Why is it important to analyze data after each test?

Assignments (Homework)

Build individual scale model of proposed vehicle.

Materials Needed

Scale Model:

model stage
tag board
elmers glue
stencil knife
markers
rulers
compass
pencils

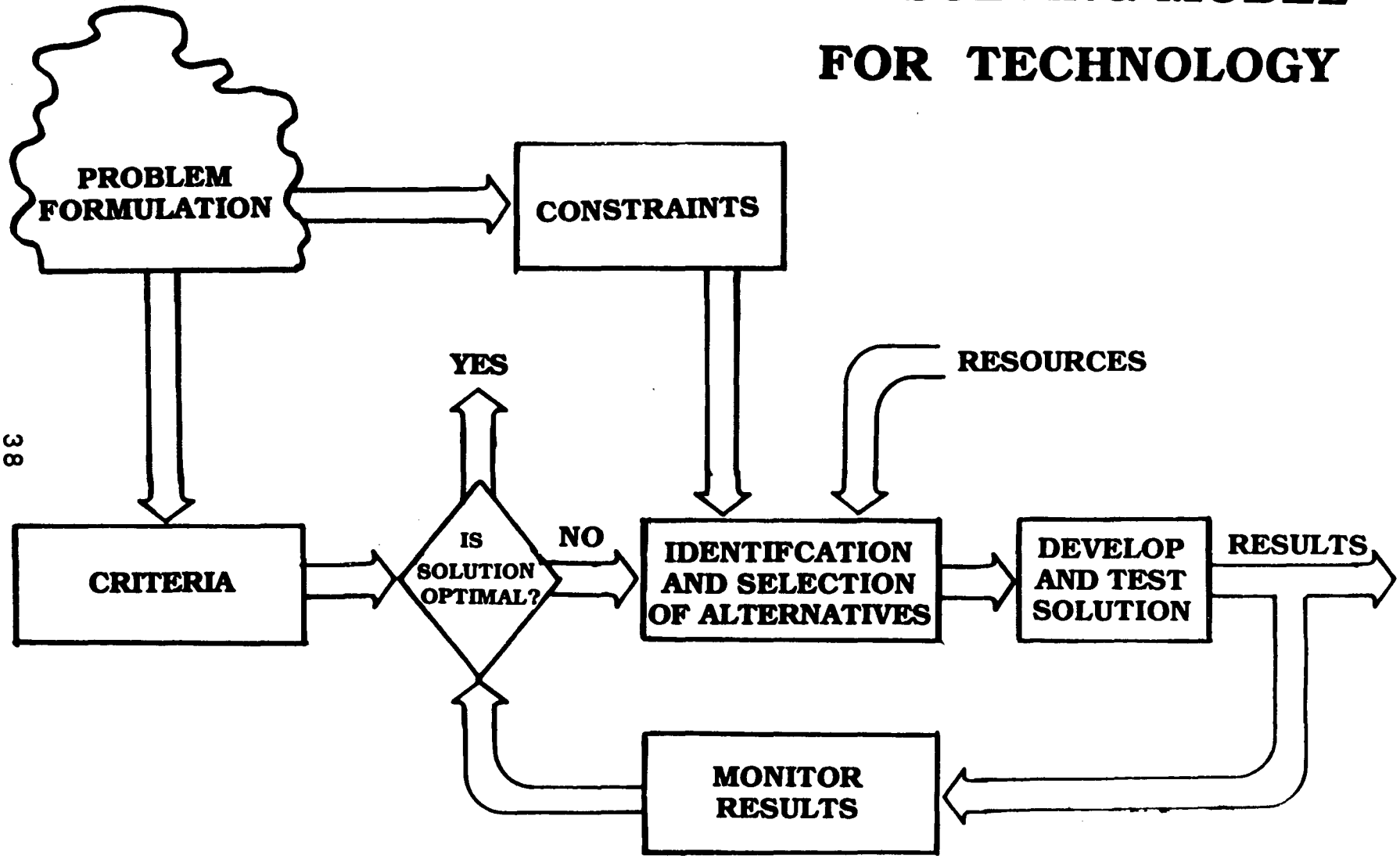
Full Size:

cardboard (refrigerator boxes)
utility knives
rulers
straight edge
elmers glue
boxing/shipping tape
spray paints
brushes

TERMINOLOGY

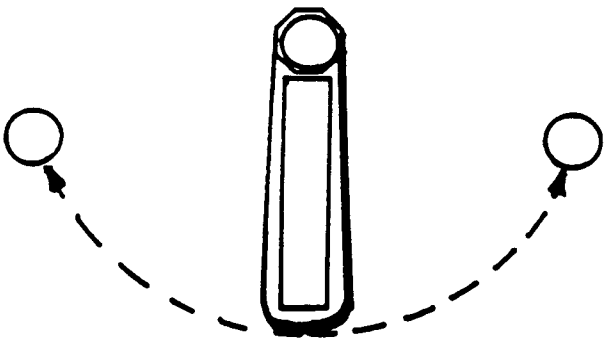
1. ergonomics
2. applications
3. human factors engineers
4. usability
5. utilization
6. analysis
7. design
8. evaluation
9. function
10. form
11. optimize
12. paraplegic
13. hemiplegic
14. quadraplegic

A PROBLEM SOLVING MODEL FOR TECHNOLOGY

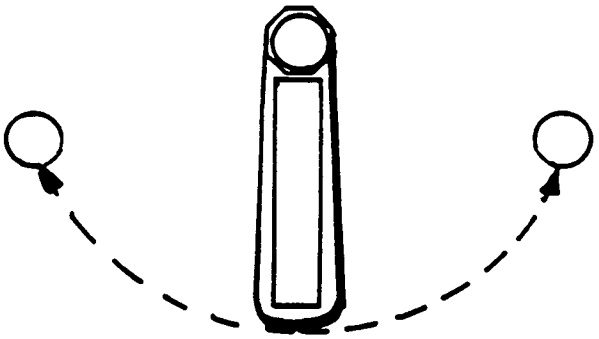


(ERGONOMICS - HUMAN ENGINEERING APPLICATIONS)

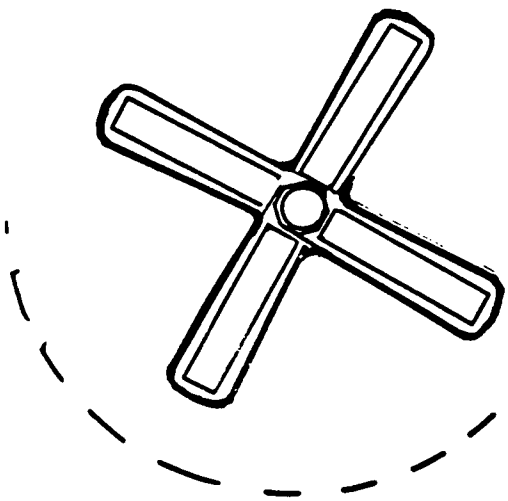
WATER FAUCET HANDLE PROBLEM



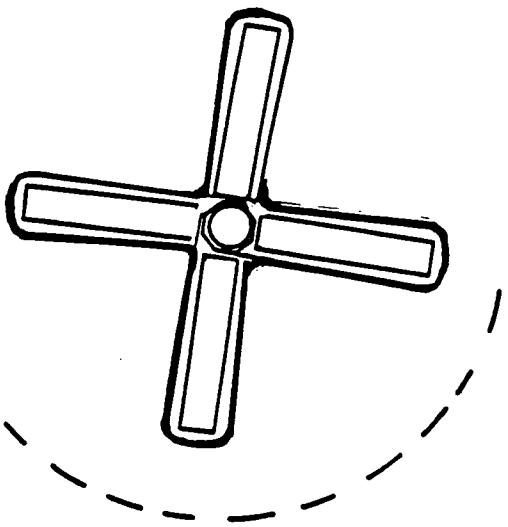
Hot Cold



Cold Hot



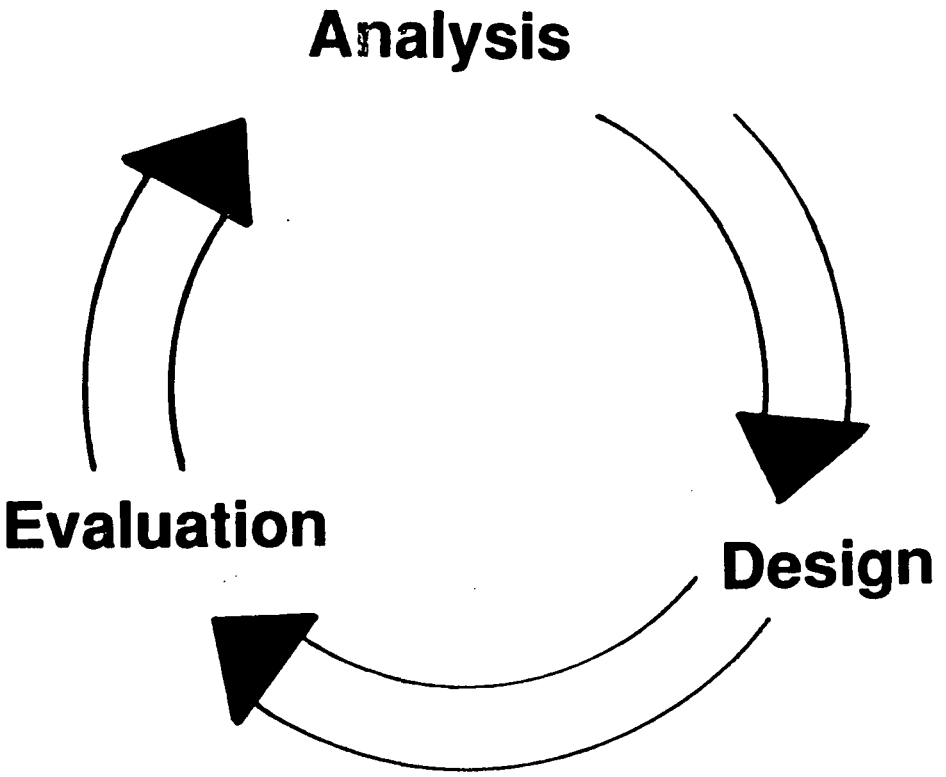
Left Right



Left Right

1. Circle word hot/cold to label standard handle
2. Make an 'x' in the circle to show the on position.
3. Draw an arrowhead on end of dashed line to show the direction to turn water on.

How many had? Percent of Agreement



THE PROCESS IN PROBLEM SOLVING

OBJECTIVES and MEASURES
Used in Human Factors Engineering

I. Human Factors Objectives	TYPICAL MEASURES
Performance Enhancement	SPEED ACCURACY
Resource Conservation	WORKLOAD SKILL DEMANDS
Acceptance	PREFERENCE OPINIONS
Cost Reduction	TIME MATERIAL
Welfare	ACCIDENTS INJURIES

ANALYZE REQUIREMENTS

OBTAIN & APPLY BEHAVIORIAL INFORMATION

SPECIFY DESIGN

TEST & MODIFY DESIGN

IMPLEMENT USAGE

GOING BEYOND:

ADDITIONAL STRATEGIES

(* - Suitable for Health Occupations Students)

1. Design and build a mini-racer (skate board wheels), push cart or coaster design, ramp or push power, gym course layout.

2. Design and build a soap box derby racer for competition.

3. Design and build a snow coaster for downhill competition using cardboard boxes, tape, and glue.

*4. Design a play vehicle that would allow a paraplegic student more freedom of movement on a gym floor.

*5. Design a "helping tool" for a disabled person, e.g., for an arthritis sufferer.

*6. Design a "walker/seat" that can be used by adults.

*7. Do a survey of what "bugs" people about certain designs and try to make or suggest an improvement.

*8. Solve the problem of having a short person observe an event from the back of the crowd, e.g., periscope, riser/stool, etc.

9. Use the Buick, Chevrolet, or Ford computer disk programs to examine specifications of new cars (free disks for Mac, IBM, Apple II), e.g., part on fitting people and luggage, car/station wagon.

10. Use the "Design a Car" program for the Apple II.

11. Customize a new car by cutting up sales catalog photos (model end surplus from local dealer) and reassemble as a custom. Your design should be ergonomically correct.

12. Write a one page "User's Manual" for a telephone (or some other simple and common office/household product that is accessible to the group).

13. Write a one page "User's Manual" for a telephone intended for international markets. Do not use any words.

14. Develop a checklist to evaluate the "ease-of-use" of common consumer products.

15. Conduct an evaluation of an at-hand product using the checklist in #14.

16. Conduct an evaluation of the safety of a child's toy or of some other common product.

17. Choose a common product or service and identify the potential errors that could be made in using this product or service. How might different user groups be more likely to make some types of errors? Identify the source of the potential errors and suggest possible re-design solutions.

*18. Have the students simulate various physically handicapping conditions using the resources provided by the instructor (e.g., wheelchair, tie thumb and forefinger together, goggles for tunnel or half vision, gloves for touch). Problem solving techniques could be identified here.

*19. Ask students to attempt normal daily activities while simulating a handicapping condition (e.g., eating while blindfolded; drinking from a fountain while in a wheelchair; going from point A to point B while blind; transferring from wheelchair to other surface; putting a jacket on with one arm; opening anything with one hand; eating without the use of a thumb; communicating with a deaf person; determining hot and cold with heavy mittens on).

*20. After experiencing the handicapping condition noted in #19, have the students record their feelings and list various ideas that may help improve/correct the handicapping condition. (Brainstorming may be used at this point).

*21. Using the formal problem-solving method, have the students devise/simulate device(s) to help improve/correct handicapping conditions.

*22. Visit an elderly or a handicapped individual to realize their ongoing problems and list these as an out-of-school assignment. Identify commercial devices which may alleviate these difficulties.

*23. Take a field trip to a Cerebral Palsy Center for the Disabled, Developmetal Center, Association for Retarded Citizens, Senior Citizens Center, etc.

*24. Have students measure, record, and average the sizes of classmates in areas such as total height, sitting height, and distances from elbow to floor. Discuss how this information can be used to help design products.

*25. Show the videotape "Miraculous Machines" by National Geographic. This film depicts the use of robotics to assist the handicapped.

*26. Show the videotape "Feedback" which is a segment of Search for Solutions available from Phillips Petroleum. Phillips provides a master tape and allows you to make your own copy.

*27. Have the students identify everyday situations where ergonomics is important to the elderly and/or handicapped.

*28. Have students evaluate accessibility and use of everyday facilities by wheelchairs in public places. (e.g. movies, church, shopping mall, school.)

CAREER INFORMATION SHEET

Career Title:

Ergonomists/Human Factors Engineers

Description of Career Responsibilities

Ergonomists work to design products and places compatible with human capabilities and limitations. These must meet eight criteria.

1. They must be safe to use.
2. They must be practical and easy to use.
3. They must be durable -- not break down or wear out too soon.
4. They must fit in with other machines or equipment and must match their surroundings.
5. They must be usable and meet the needs of the user.
6. They must be comfortable.
7. They must not disrupt working relationships or work routines.

Educational Requirements

At least a Bachelor's degree -- start as laboratory associates, research assistants or staff workers.

Masters -- administrative or higher research positions.

Doctorate -- may teach college, do research or serve upper management and other special positions.

Skills or Personal Attributes Needed

Be able to design, analyze, supervise, manage, conduct experiments in field and laboratories, teach, conduct seminars, write and answer letters, make telephone calls, write reports, make speeches, attend meetings, make decisions, and solve complex problems.

Salary Level

Above average.

Employment Opportunities

Laboratory assistant
Laboratory associate
Researcher
Design engineer
Administrator

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Eastman Kodak Company. (1983). Ergonomic Design for People at Work, Volume 1. Belmont, CA: Lifetime Learning Publications.

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*Gay, K. (1986). Ergonomics: Making Products and Places Fit People. Hillside, NJ: Enslow Publishers.

*Human Factors Society. P.O. Box 1369, Santa Monica, CA 90406.

*I.B.M., Ergonomics Handbook Armonk, NY: International Business Machine Corporation.

Norman, D.A. (1988). The Psychology of Everyday Things. NY: Basic Books.

*Pelsma, K.(1987). Ergonomics Sourcebook. A Guide to Human Factors Information. Lawrence, Kansas: The Report Store, A Division of Ergosyst Associates, Inc.

Rubinstein, R. and Hersh, H.M. (1984). The Human Factor. Burlington, MA: Digital Press.

Woodson, W.E. (1981). Human Factors Design Handbook. New York: McGraw-Hill.

Other Resources

Technical Schools

SUNY Buffalo, Surface Science Center

Trainex (see below)

School Nurse

Ferris, Skelly and Dorig. Basic Standards and Functions. Delmar Publishers, Albany, 1981.

* - Recommended

Hacker and Barden. Technology in Your World. Delmar Publishers, Albany, 1987.

Todd, McCrory, Todd. Understanding and Using Technology. Davis Publications, Inc., Worcester, MA., 1985.

1985 Book of ASTM Standards. American Society for Testing and Materials.

The World of the Future: Robots, Science and Medicine into the 21st Century. Usborne Publishing, Ltd., 20 Garrick St., London, WC2E 9BJ.

VIDEOS AND FILMS

Concept Media, P.O. Box 19542, Irving, CA 92712. (800-253-7078).

Trainex Corp., P.O. Box 116, Garden Grove, CA 92642. (800-854-2485).

Human Factors Society - Human Factors Success Stories (1987). Santa Monica, CA: Human Factors Society.

Health Occupations Education Core Curriculum.

Introduction to Technology Curriculum.

Craft, Design, and Technology for G C S E (Peter Toft), Heinemann Educational Books, Ltd., 22 Bedford Square, London WC1B 3HH.

"Miraculous Machine" by National Geographic, National Geographic Society, 17th and M Street, NW, Washington DC 20036.

MAGAZINES/NEWSLETTERS

National Geographic Index (e.g. Bio-Med Technical Equipment-June 1986 issue). National Geographic Society, Washington DC 20038.

Fortune Magazine weekly section on Technology, Science & Health. Time Life Building, Rockefeller Center, New York, NY 10020-1393.

Insight Magazine weekly sections on Science briefings. Health, Legal and Legislative briefings, 3600 New York Avenue, NE, Washington DC 20002.

Breakthroughs, Weekly Newsletter, Boardroom Reports, $49/yr. Contains latest inventions, purpose & applications; by whom, where, when available, 330 W 42nd Street, New York, NY 10036.

Mayo Clinic Health Newsletters by Mayo clinic updates on equipment, techniques, procedures. Rochester, Minn.

* - Recommended

Healthwise Newsletter - Biweekly update on Equipment Pharmaceuticals, Treatments, Surgeries. P.O. Box 1786 Indianapolis, IN 46206.

T.H.E. Journal, Technological Horizons in Education, 2626 South Pullman, Santa Ana, CA 92705.

* - Recommended

SOCIETAL WASTE: PREVENTION, PROCESSING, TOXICITY

INTRODUCTORY STATEMENT

This unit of instruction contains model lesson plans and activities to focus on the subject area, "societal waste," a topic under the biotechnological umbrella. Biodegradation of waste is emphasized to demonstrate certain principles.

This unit is prepared for use by both health occupations and technology educators. Lessons are directed to major topics dealing with solid waste. Two major activities are included, one to be conducted as a hands-on activity with on-site supervision, and the other off-site, at home with focus on research and observation.

Participants

Neal Swernofsky
Clark Green
Richard Luce
Helen Burrill
Willie Ostrander
James Duffy

LEARNING ACTIVITY BRIEF

Topic:

Societal Waste: Prevention, Processing, Toxicity

SYLLABUS CONNECTIONS:

T-5 How Technology Affects People and the Environment
T-8 Controlling Technological Systems
T-10 Using Systems to Solve Problems

HOE CORE Mod - Microbes and the Environment
Mod - Maintaining and Promoting a Safe Environment

GOAL:

To understand the impact of societal waste products on the environment and the use of microbes to control waste and waste by-products.

OVERVIEW:

As the population increases, the impact of waste on the environment threatens all living species. This activity models the affects of toxic waste levels on the environment and their implications upon society. Students will be introduced to biotechnological techniques for processing various waste products. The use of microorganisms in the processing of these waste products will be investigated.

MATERIALS: (Per model unit)

- ring stands
- two ring clamps
- graduated beaker
- two plastic soda pop bottles, bottoms removed

Supplies:

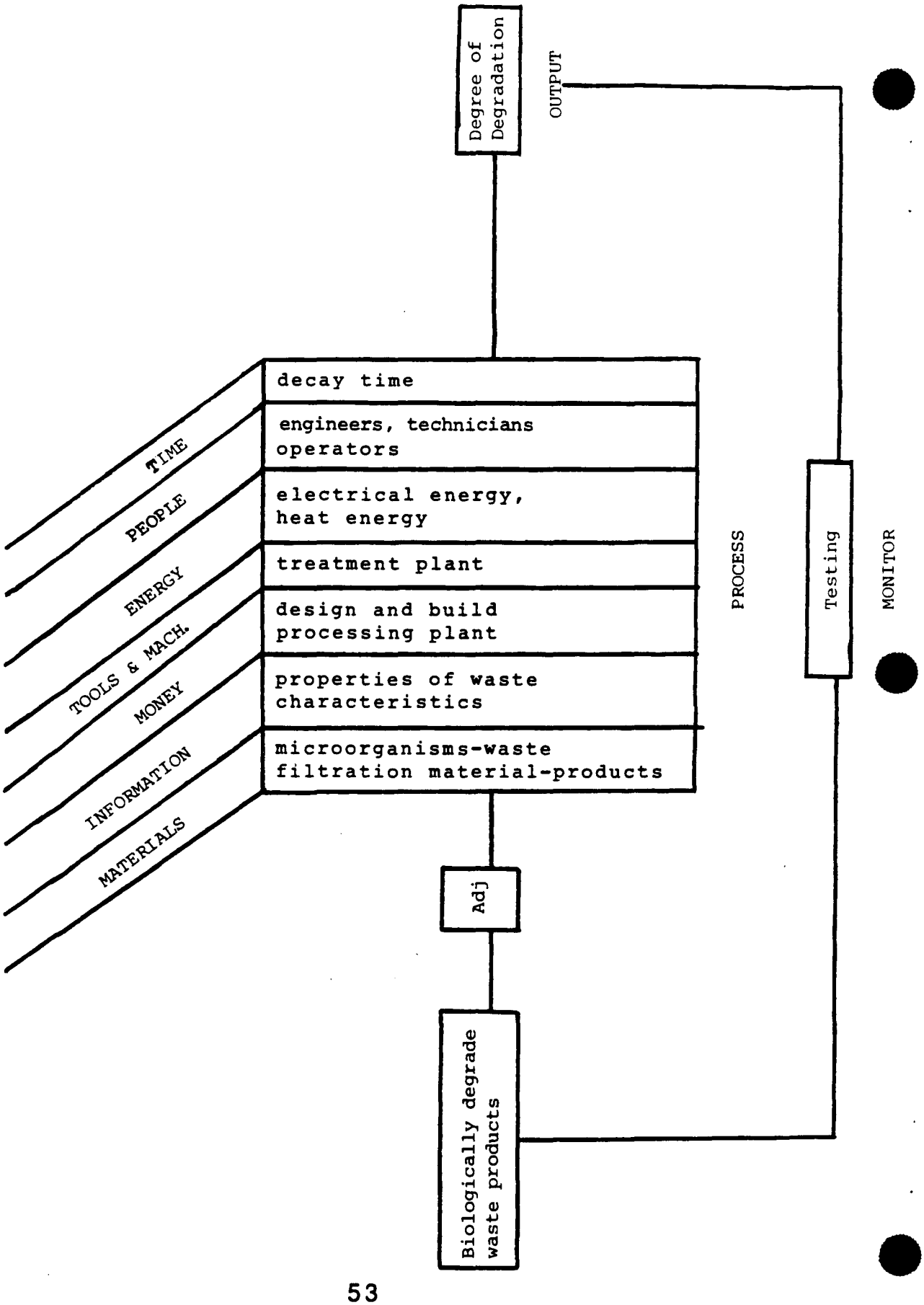
- five pounds of soil (non-sterile)
- waste: oil, turpentine, coffee grounds, soap suds, starch, latex paint
- sewage sludge (refrigerate)
- pH paper
- soda ash, vinegar
- basic bacterial plate kits including petri dishes and mediums, enough for class
- filtration system (sand, activated charcoal, filter paper)

DISCUSSION TOPICS:

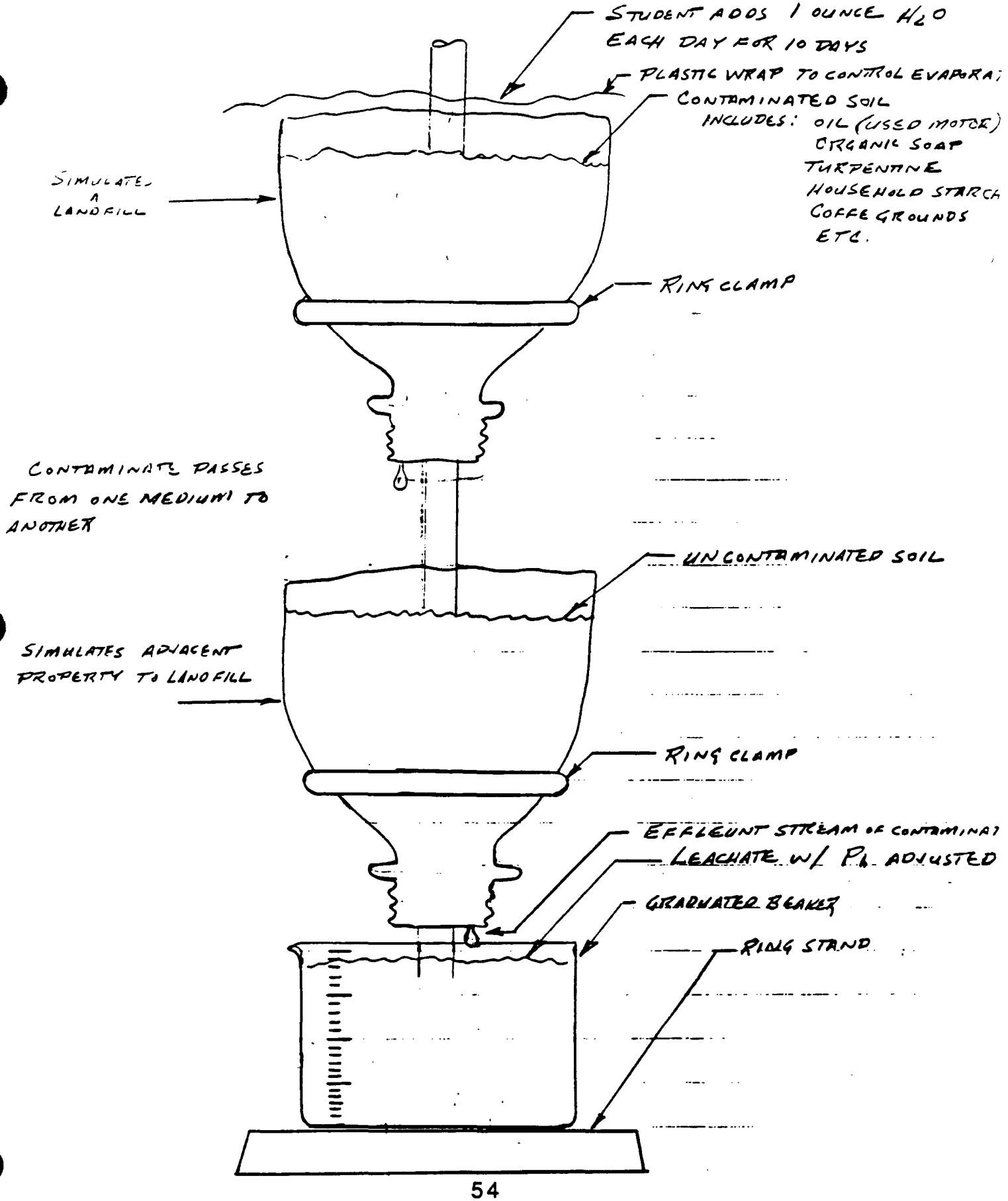
1. Environmental and social impacts of societal waste.
2. Origins of societal waste.
3. Processing societal waste: biodegradation, landfill, incineration, incapsulation.
4. Bioassay -- determining the relationship between toxic agents and concentrations.
5. Leachate formation.
6. Toxicity of poisons to living organism.
7. Waste management occupations.

ACTION PLAN: Leachate must be prepared 10 days in advance

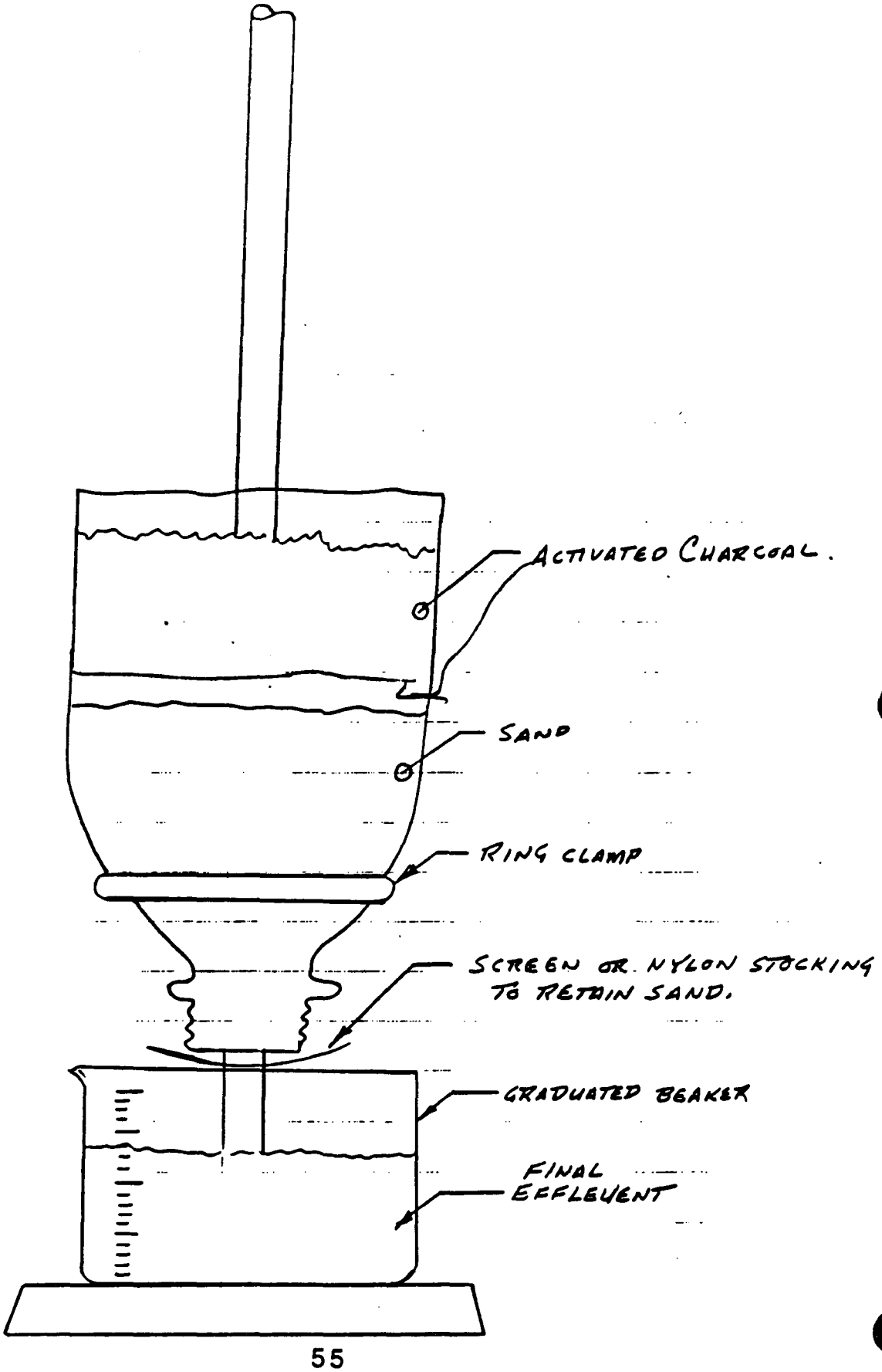
1. Develop a prototype that will model the production of leachate (e.g., model land fill, see diagram).
2. Collect leachate after a 10 day period, prepare a working solution of 10 parts water to one part leachate.
3. Obtain a PH of 7 to 7.5 solution (use vinegar to lower pH, soda ash to raise pH).
4. Divide the working solution among pairs of students.
5. Have students record the physical properties of working solution as well as concentrated leachate (see data sheet).
6. Have each pair of students introduce microorganism (sewage sludge) into working solution and store at room temperature for two days (70 - 75 degrees). (Two ml added per 100 ml working solution.)
7. After two days, compare physical characteristics of the leachate to original working solution and record data on data sheet.
8. Percolate this solution through filtration system (see diagram) and record physical characteristics of effluent.
9. Students will now demonstrate the presence of microorganisms involved in the treatment of waste products.
10. Using two factory prepared culture dishes, spread a sample of sludge in one and leachate working solution in the other. After two days, observe and record information on microorganism growth on data sheet.
11. Kill all bacteria at the end of activity by soaking culture dish in clorox bleach and discard.

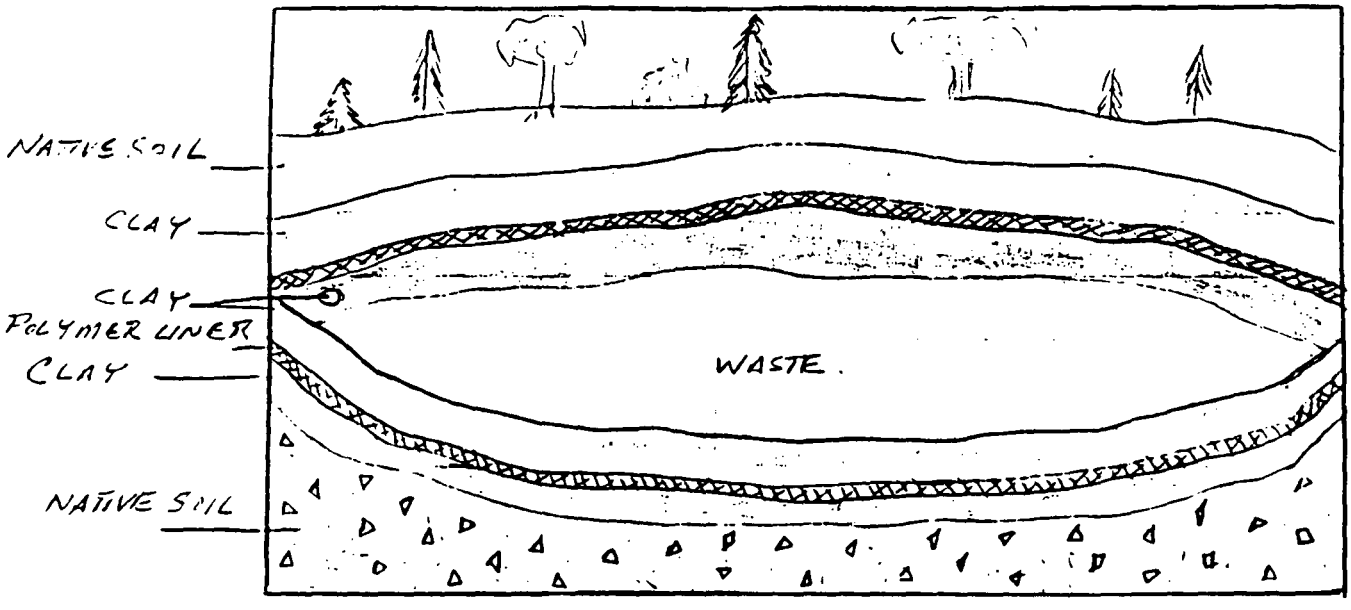

Degree of Degradation
OUTPUT
TIME
PEOPLE
ENERGY
TOOLS & MACH.
MONEY
INFORMATION
MATERIALS
decay time
engineers, technicians operators
electrical energy, heat energy
treatment plant
design and build processing plant
properties of waste characteristics
microorganisms-waste filtration material-products
PROCESS
Testing
MONITOR
Adj
Biologically degrade waste products

MODEL LANDFILL



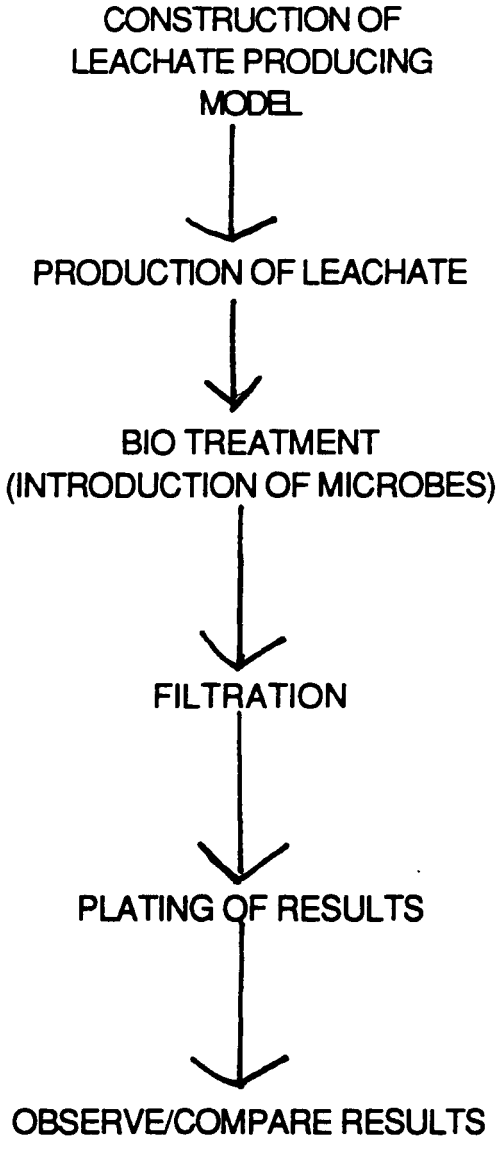
FILTRATION SYSTEM





TYPICAL LANDFILL DESIGN

LAND FILL SUMMARY



WASTE TREATMENT DATA SHEET

STUDENT'S NAME _____

OBSERVATION #1 - CONCENTRATED LEACHATE

COLOR _____

SMELL -- SOUR/SWEET/SHARP

VISCOSITY -- WATER-LIKE
OIL-LIKE
MOLASSES-LIKE

SKETCH #1

AMOUNT COLLECTED _____

DESCRIBE APPEARANCE:_____

_____

OBSERVATION #2 - DILUTED LEACHATE WORKING SOLUTION

COLOR _____

SMELL -- SOUR/SWEET/SHARP

VISCOSITY -- WATER-LIKE
OIL-LIKE
MOLASSES-LIKE

SKETCH #2

AMOUNT COLLECTED _____

DESCRIBE APPEARANCE:_____

_____

OBSERVATION #3 - WORKING SOLUTION AND MICROORGANISMS AFTER TWO DAYS

COLOR _____

SMELL -- SOUR/SWEET/SHARP

VISCOSITY -- WATER-LIKE
OIL-LIKE
MOLASSES-LIKE

SKETCH #3

AMOUNT COLLECTED _____

DESCRIBE APPEARANCE:_____

_____

OBSERVATION #4 - FINAL EFFLUENT (FINAL FILTRATION)

COLOR _____

SMELL -- SOUR/SWEET/SHARP

VISCOSITY -- WATER-LIKE
OIL-LIKE
MOLASSES-LIKE

SKETCH #4

AMOUNT COLLECTED _____

DESCRIBE APPEARANCE:_____

_____

OBSERVATION #5 - CULTURED MICROORGANISM

<u>Working Solution</u>

Shape of colonies Rod-like
Circular
Fuzzy

Luster

Percent of plate covered

_____%

<u>Sludge</u>

Shape of colonies Rod-like
Circular
Fuzzy

Luster

Percent of plate covered

_____%

DAILY LESSON PLAN

Topic

Characteristics of Waste and Resultant Impacts Upon Society

Syllabus Connections

T-5 How Technology Affects People and the Environment
T-8 Controlling Technological Systems
T-10 Using Systems to Solve Problems

HOE CORE Mod - Personal Health and Wellness

Setting the Stage

Beginning with clean pitcher of water, add sludge and stir to visually demonstrate the basic process of pollution.

Structure of Lesson

1. Class discussion to develop list of sources for waste.
2. Determine variations of waste emanating from sources and list types of waste.
3. Investigate how and where waste has been or is commonly disposed.
4. Present learning aids to show students common actions of dumped waste when exposed to hydrological cycle.
5. List potential impacts of waste products on drinking water supply.
6. Decipher impacts upon nature, individuals, and society for the present and future.

Summary Questions

1. What personal changes can we make to begin to correct and/or prevent these problems?
2. What actions should society and government take to clean up present pollution?
3. What technologies are present or could be developed to correct this situation?

Assignments

1. Find a local source of untreated pollution; or,
2. Secure a news or magazine article highlighting a pollution sight and/or clean up effort.

Materials Needed

- pollution leachate model
- statistics of pollution effects
- videotapes or slides focusing upon an exemplary pollution site

DAILY LESSON PLAN

Topic

Processing Societal Waste: Biodegradation, Landfill, Incineration, Incapsulation

Syllabus Connections

T-5 How Technology Affects People and the Environment
T-8 Controlling Technological Systems
T-10 Using Systems to Solve Problems

HOE CORE Mod - Microbes and the Environment
Mod - Maintaining and Promoting a Safe Environment

Setting the Stage

Pre-mix a solution of sand, pepper and water in a container. Demonstrate how these ingredients can be filtered from the solution by pouring it through a coffee filter paper. Many of the waste products that have polluted our land and water can be processed out of the environment.

The waste products of society can be discarded in a variety of ways that will have less of an impact on society and the environment.

Structure of Lesson

1. Depending on the type and place, waste products are found, and different techniques are used to process them.

   Biodegradation -- the use of microorganisms to degrade waste products

   1. What are microorganisms
   2. Applications in sewage treatment
   3. Applications in toxic waste sites

   Land Fills -- create a safe cavity within the earth to place non-toxic and toxic solid waste.

   1. How does a well-designed land fill work? (see diagram)

   Incapsulation -- using well-designed containers to contain certain hazardous materials.

   1. Many materials are incapsulated in cement and silica products and later deposited in land fills or other places.

Incineration -- the burning of waste products in an incinerator.

1. Municipal applications - garbage, medical products and by-products

Summary Questions

1. Describe two methods of safety dealing with waste products produced by society.
2. How is the incapsulation method different from the landfill method in dealing with waste products?
3. What is the role of microorganism in biodegradation?

Assignments

None

Materials Needed

- sandpaper
- water containers
- coffee filter
- diagrams

Outside References

Hazardous Materials Control periodical; HMCRI, P. O. Box 8905, Boulder, CO 80328-8905.

DAILY LESSON PLAN

Topic

Toxicity of Poisons

Syllabus Connections

T-5 How Technology Affects People and the Environment
T-8 Controlling Technological Systems
T-10 Using Systems to Solve Problems

Setting the Stage

The influence of societies' waste on living organisms. Bioassay determines the relationship between toxic agents and concentrations.

Structure of Lesson

1. Add the final leachate to a bowl of brine shrimp or guppies and observe over a period of days the activity/health of the specimen (leachate should be a high percentage concentration in the bowl).
2. Encourage a conversation about the use of animal organisms in biotechnology. Probe students to consider using saprogenic animals in the interest of protecting or preserving human life.

Summary Questions

Think carefully -- are there ethical questions about this test? Do you feel this kind of experimentation is justified? If the fish had died, how would you feel?

Assignments

Discuss this ethical question with classmates or parent/guardian until you have resolved a position you can describe. Be prepared to complete the statement: "I feel that the use of animals in biotechnology is ....".

Materials Needed

- fishbowl
- tap water at ambient temperature
- brine shrimp/guppies
- final effluent

DAILY LESSON PLAN

Topic

Tracing of disposable diapers with fecal matter -- from use to landfill.

Syllabus Connections

T - 5 How Technology Affects People and the Environment
T - 8 Controlling Technological Systems

HOE CORE Mod - Personal Health and Wellness
Mod - Microbes and the Environment
Mod - Maintaining and Promoting Safe Environment

Setting the Stage

What happens to a disposable diaper filled with B.M. (fecal matter)?

Structure of Lesson

1. Have students trace what happens to a dirty disposable diaper from use to the land fill.

   a. Baby or toddler
   b. Folded to contain waste; diaper pail -- growth of organisms
   c. Garbage can
   d. Pick-up by garbage truck
   e. Transport to land fill
   f. Dumped on site
   g. Non-biodegradable so remains intact due to warmth, darkness and moisture (which is growth media for bacteria). Will multiply the E-coli bacteria (anaerobic/aerobic) in stool, and yeast in urine if present.
   h. Spread by rodent and insect population to adjacent land fill areas and into food chain, or be leached into the water table, river and lakes.
   i. Animals eating grass or garbage.
   j. We, in turn, digest milk, meat, fish or poultry products from these animals.

2. Correlate with dirty cloth diapers

   a. Baby or toddler
   b. Rinsed out in toilet and flushed -- disposing into sewage treatment plant cleansed and recycled, or septic tanks that are treated by the addition of lime
   c. Diaper pail containing bleach (clorox) and water for soaking and disinfecting
   d. Washed with detergent and hot water for additional cleaning; dried in dryer or outdoors; no detrimental impact on the environment
   e. Recycled into rags, etc.

Summary Questions

1. What impact does advertising have on the use of disposable diapers?
2. Who funds this advertising and why?

    a. Big business
    b. Capital gains

3. Does the profit motive constrict societies interest?
4. Does the advertisement tell you about the adverse effect on the health and environment?
5. Did the diaper companies give the public enough information to make an intelligent decision about using disposable diapers in relation to its impact on health and wellness and our environment?
6. What do we do when our landfills might be closed within a year?

    a. Incineration -- only other choice

7. Where is the ash from the plastic going to be disposed of? -- road beds, asphalt, concrete

    a. If disposed of in this way, what will the future impact be?

Assignments

1. Survey of neighborhood for number of babies and toddlers using disposable diapers.
2. How many are using cloth diapers?

    a. How many used per week?
    b. What is cost per week of each; include cost of laundry if cloth (detergent, water, clorox, electricity). If laundromat - $1.00/washer; $1.00/dryer.
    c. Diaper service.

3. How much does it cost to clean up a landfill? ($50 to $150 per cubic yard)
4. Write disposable diaper companies to find out:

    a. Have they, or are they now, concerned with their products' effects on the environment?
    b. Did they ever consider this problem when they were developing their product?
    c. Have they any suggestions or will they change their product in any way to relieve this problem?

Materials Needed

- one cloth baby diaper
- one disposable baby diaper
- one adult diaper

CAREER INFORMATION SHEET

Career Title:

Waste Management as a Chemist, Technician, or Engineer

Description of Career Responsibilities

Measure, manage, design, communicate, operate

Educational Requirements

Two year technical degree (minimum) in physical and biological sciences.

Skills or Personal Attributes Needed

Skills:
- science
- math
- English/communication
- computer

Personal Attributes:
- able to work in groups
- quantitative skills
- analytic

Salary Level

Above average

Employment Opportunities

Industry
Municipal
Research
Academic
Government

(See attached reference material)

Career Awareness

Environmental Technology

Waste Remediation

CHAIR
COLLEGE OF ENGINEERING
Michigan Technological University

The College of Engineering at Michigan Technological University is pleased to announce the creation of the Ventures Chair in Engineering with emphasis in one or more areas of waste management, resource recovery, and environmental systems. This is part of a rapidly developing sphere of excellence in the University. Applications and nominations are invited for the professorial position. The successful candidate should possess recognized academic and practical experience. Background in management of industrial and hazardous waste and/or specialized areas of resource recovery technology will be an advantage.

The College of Engineering has degree and research programs in several areas related to waste management, resource recovery and environmental systems. Significant contribution to the existing educational and research programs as well as broad scale involvement in the promotion and development of new programs is expected. Departmental affiliation for the position is open and will depend on the background of the successful candidate.

CHIEF, LABORATORY SECTION
($36,500 – $50,000)

The New York City Department of Environmental Protection has an immediate opening for a Chief of its Water Pollution Control Laboratory Section. This is a fine managerial career opportunity with excellent benefits.

The Chief of the Laboratory Section reports to the Chief of the Division of Operations Control and is responsible for planning and directing the technical and administrative operations of all the laboratories engaged in the analysis of waters and wastewaters.

ENVIRONMENTAL PERSONNEL INC., the search and specialist for the environmental industry, is seeking key individuals for the following positions.

CORPORATE MANAGER OF BIODEGRADATION Degree in Biology, Chemical Engineering, or related science, with an advanced degree preferred. Familiar with in-situ biodegradation, land treatment systems, pilot scale or demonstration projects, and RCRA permitting requirements. Houston and Denver locations available.

MANAGER OF HYDROGEOLOGY -Degree and experience with ground water, near surface geology, RCRA and/or CERCLA. Houston and Los Angeles locations available.

SENIOR PROJECT MANAGER -Must have experience managing multiple hazardous waste projects at the same time. Marketing skills would be a plus. Supervisory knowledge of RCRA and/or CERCLA. Requires degree with P.E. preferred. Houston, Denver, Chicago, and Los Angeles locations availa-

LABORATORY MANAGER

Financially strong, growing firm supplying a broad range of consulting engineering and laboratory services to a wide range of clients in the Mid-Atlantic States seeks a senior level manager for a well equipped analytical laboratory and its 35+ employees. Laboratory activities and predominantly in the environmental and industrial hygiene areas and have benefited by the full service approach of supplying both engineering and laboratory services to clients. Applicants should possess a broad background in laboratory operations, including marketing and sales. Progressive managerial experience is required and advanced degree in technical area or business management desired.

AQUATIC TOXICOLOGIST

$42,180-$59,040
Comprehe...
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Ea...
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ENVIRONMENTAL CONSULTING

Mid-size expanding firm has immediate opening for experienced consultant to manage existing branch office in Milwaukee area. Responsibilities include business development; senior level consulting in air, water, hazardous waste and permitting; management of staff and laboratory oversight.

Candidate must possess excellent oral and written skills, demonstrate technical ... ness experience in above ... 10 years in one ...

Benefits
...ay Area

...test independently operated ...ce this new position in our ...

ENVIRONMENTAL CHEMISTS

ROY F. WESTON, INC., a leader in the field of environmental engineering for over 30 years, has positions open in state-of-the-art analytical laboratories in Edison, NJ; Chicago, IL; and other locations throughout the U.S. Personnel are needed in the following areas:

CHEMISTS/SCIENTISTS with BS or M... Chemistry and six years experience ... vironmental analysis. Familiarity w... or more of the following requir... GC/MS, QA/QC, CLP, QAPP pr... data review and supervisory ex...

AIR QUALITY RESEARCH PROJECT MANAGER

Environmental And Safety Research

If you're thoroughly knowled... quality, we have a chall... Gas Research Institute, a ... organization serving th... ...nmental and Safet... ...for developin... ...amb...

SANTA BARBARA COUNTY AIR POLLUTION CONTROL DISTRICT

...is expanding. We are looking for qualified ...air quality professionals who are interested in challenging work in technology development, permitting, compliance review, inspection, toxics, rulemaking and ambient monitoring.

We have over 30 vacancies, which in... disciplin...

3 TENURE-TRACK FACULTY POSITIONS for August 1988 at assistant/associate professor level: an Organic Chemist and an Analytical Chemist, Ph.D. required; postdoctoral experience desirable. Teaching at graduate/undergraduate levels. Especially interested in those with active research programs in environmental chemistry. Send vita, transcripts, research plans, 3 letters to: L. Keller, Dept. of Chemistry, Florida International University, Miami, FL 33199. Closing date: 2/11/88. FIU, The State University of Florida at Miami, has a current enrollment of 17,000 students. FIU has B.S./B.A. programs in chemistry and environmental studies and a new M.S. program in chemistry. New science building planned for occupancy in 1990. FIU is an AA/EO employer.

...m O... ...elated ...perienc... ...ty regulations is desirable. An ...n appropriate engineering or science ...ience in air ...research and ...desirable. Familiarity with

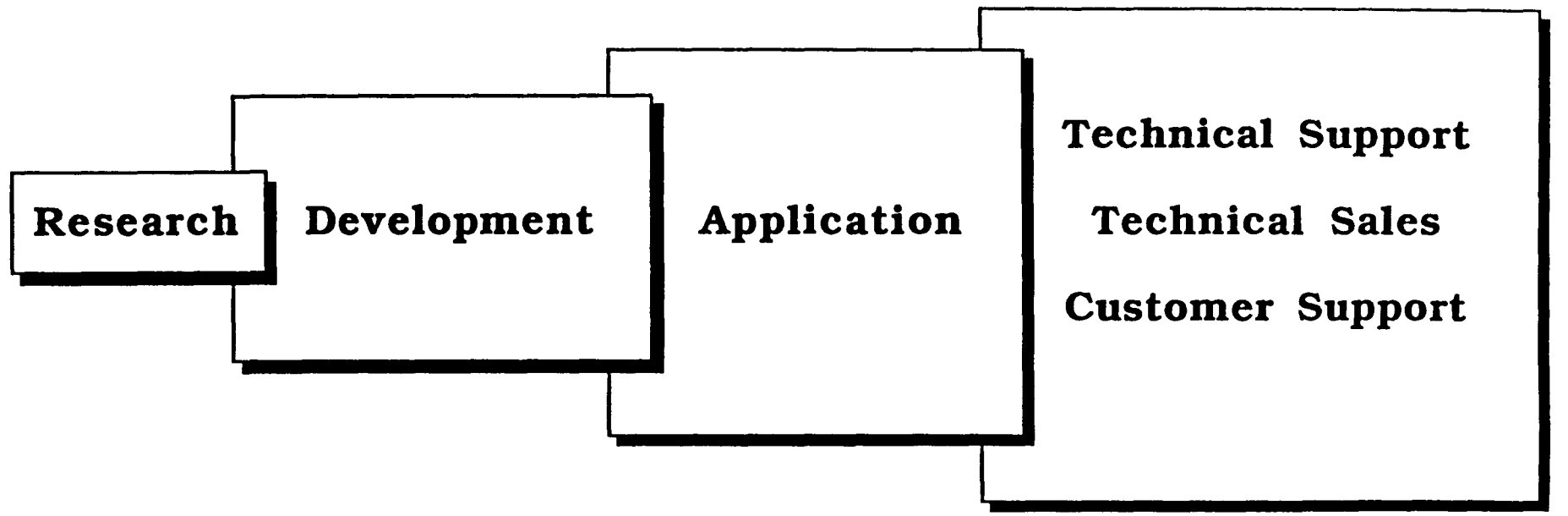
To Cover

- What Am I?
- What Do I Do?
- How Do I Become One?
- How Is It?
- Where Can I Go?

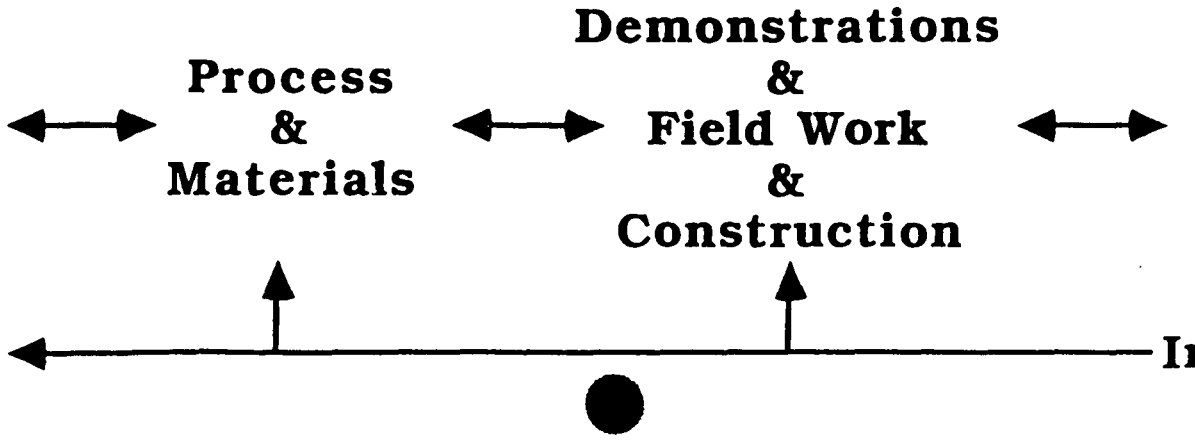
What Is An Environmental Scientist/Waste Remediation Professional?

- Chemist
  - Organic
  - Physical
  - Analytical
  - Environmantal
  - Bio
  - Inorganic
- Engineer
  - Chemical
  - Environmental
  - Civil
- Biologist
- Microbiologist
- Toxicologist
- Geologist
- Hydrogeologist
- Soil Scientist
- Lawyer

What Do I Do?


Research
Development
Application
Technical Support
Technical Sales
Customer Support

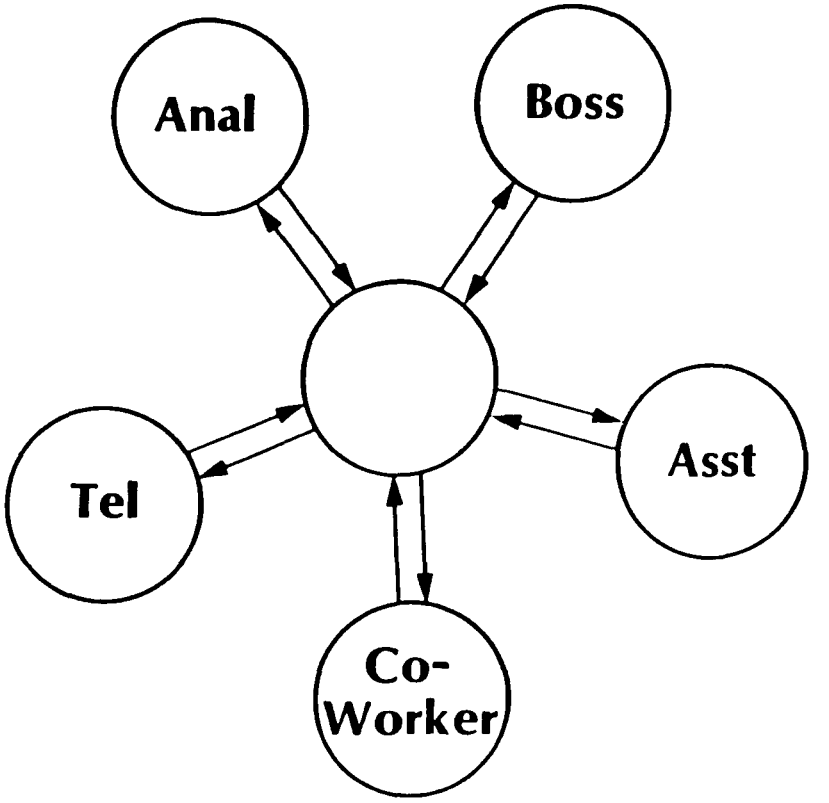
Information


Process
&
Materials
Demonstrations
&
Field Work
&
Construction
Information

WHAT DO I DO?

What Happens on Wednesday??

- Plan
- Review
- Communicate
- Calculate
- Analyze
- Communicate
- Get Physical
- Analyze



REQUIREMENTS

- **Emphasize:**
  - Science
  - Math
  - English
  - Computer
  - Plumbing
  - Electrical
  - Mechanical

REQUIREMENTS AND PLUSSES

To Get An Interview:

- GPA > 3/4
  - Top 20% of Class
  - Experience +

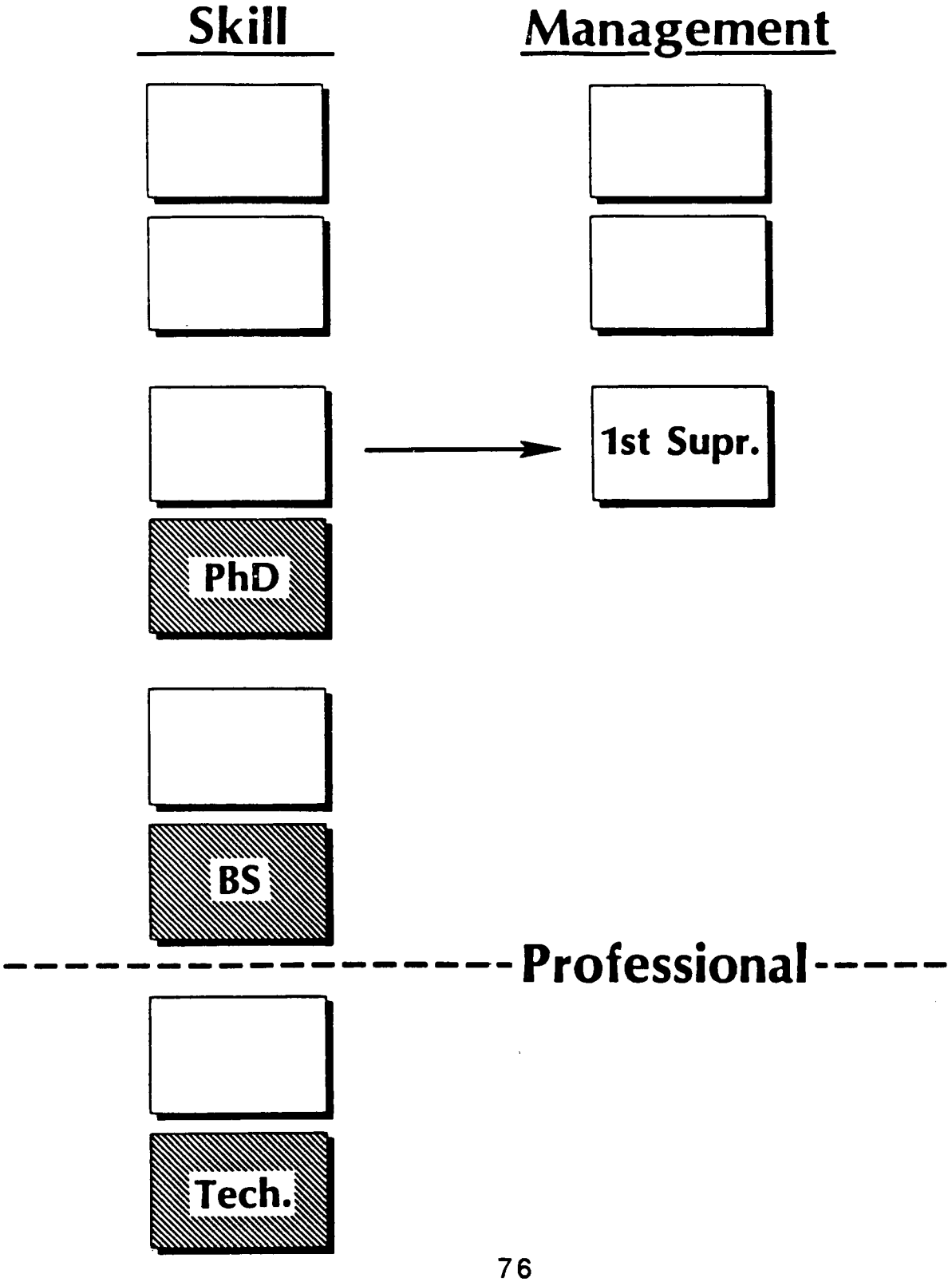
Needs:

- Training
- Written/Oral Skills
- Not a Loner
- Recommendations (Not Only School)

HOW DO I BECOME ONE?

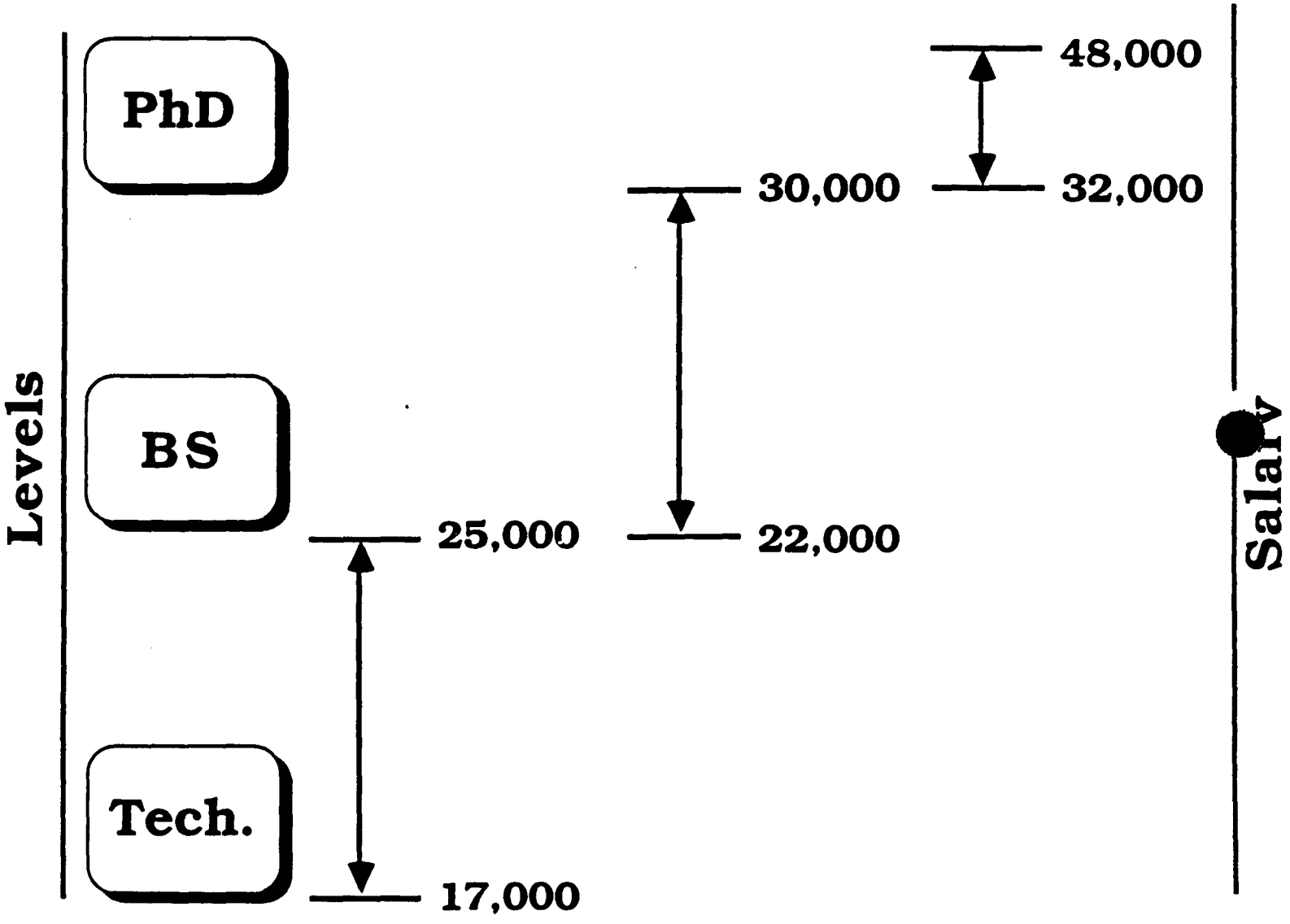
Technician	**2 yrs. College** **4 yrs. College**
Bachelors	**4 yrs. College**
Masters	**4 yrs. College + 2 yrs. Specialty**
PhD	**4 yrs. College + 4 yrs. Specialty**

HOW IS IT?

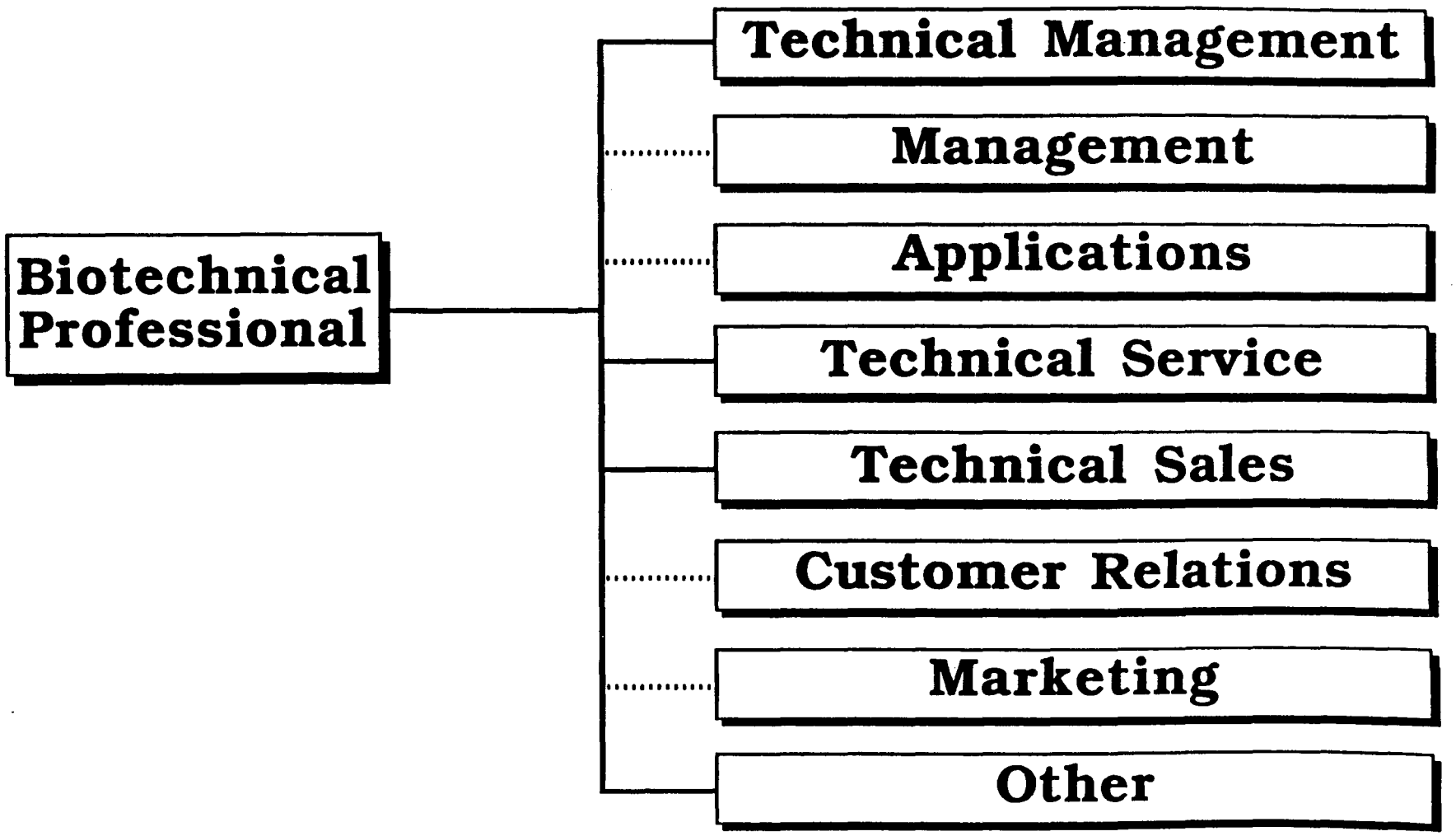


How Is It?

What Do I Earn?



Where Can I Go?



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Draft by New York State Hazardous Waste Facilities Siting Plan and Draft Environmental Impact Statement - June 1988 D.E.C.-NY.

Basic Biotechnology by John Butock, Bjorn Kristiansen, Academic Press, Inc. (London) Ltd., 1987.

Solid waste and recycling kit 66607-01. $86.50. Science Kit and Boreal Laboratories 1988/89 catalog, Tonawanda, NY 14150; or toll free 1-800-828-7777.

Johnson & Johnson, Inc.; New Brunswick, NJ 08903.

PLANT TISSUE CULTURE

INTRODUCTORY STATEMENT

This unit of instruction contains model lesson plans and activities to focus on the subject area plant tissue culture, a topic under the biotechnological umbrella. Propagation of plants by means of tissue culture is demonstrated to emphasize techniques to maintain a sterile culture.

This unit is prepared for use by both health occupations and technology educators. Lessons are directed to major topics dealing with plant tissue cultures from initation to acclimation.

Participants

Henry Harms
Tom Barrowman
Marshall Hahn
Clagett Boehner
Lois Smith
Jacqueline Stuber
Frank Darzano

LEARNING ACTIVITY BRIEF

Topic:

Plant Tissue Culture

SYLLABUS CONNECTIONS:

T-3 TLA Plants with One Parent
T-5 How Technology Affects People and the Environment
T-6 Choosing Appropriate Resources for Technological Systems
T-7 How Resources are Processed by Technological Systems
T-9 Technology and Society Now and In the Future

HOE CORE Mod - Microbes and the Environment

GOAL:

To understand and practice the appropriate techniques for asepsis, sterilization, and disinfection. To understand the concept, techniques, advantages and disadvantages of plant tissue culture. Students will learn about career opportunities in biotechnology.

OVERVIEW:

During the 1970s and 1980s there has been increasing commercial application of plant tissue culture. Agricultural, horticultural and medical establishments are using tissue culture for research and propagation. Human tissue cultures is an important aspect of biotechnology.

Through activity involving plant tissue culture, the students will learn about the regeneration of whole plants from pieces of tissue grown on a nutrient media under controlled conditions, without contamination by microorganisms.

DISCUSSION TOPICS:

1. Definition and history of tissue culture.
2. Terminology.
3. Sterile technique.
4. Safety.
5. Media preparation and constituents:

    a. organics
    b. inorganics
    c. additives

6. Stages of growth.
7. Advantages and disadvantages of tissue culture.
8. Uses of tissue culture.
9. Propagation and research.
10. Careers.

ACTION PLAN:

1. Introduction to plant tissue culture.
2. Show the basic stages in plant tissue culture:

    a. Initiation
    b. Multiplication
    c. Rooting
    d. Acclimation

3. Aseptic techniques:

    a. Handwashing
    b. Disinfecting the work area
    c. Sterilization

4. Media content and preparation:

    a. Macroelements and microelements
    b. Hormones
    c. Sucrose and vitamins

5. Demonstrate the procedure for initiating a tissue culture.
6. Have students initiate a tissue culture.
7. Have students subculture plants through stages II, III, and then transfer to stage IV and monitor growth.

DAILY LESSON PLAN

Topic

Introduction to Plant Tissue Culture

Syllabus Connections

T-5 How Technology Affects People and the Environment
T-6 Choosing Appropriate Resources for Technological Systems
T-7 How Resources are Processed by Technological Systems

HOE Core Mod - Microbes and the Environment

Setting the Stage

Plant tissue culture is used for propagation and research and has become an important aspect of biotechnology. Commercial growers use plant tissue culture because it enables them to reproduce many plants quickly.

Structure of Lesson

1. Plants have been propagated asexually for thousands of years using techniques such as cutting and grafting. Today, plant tissue culture is used to propagate many plants including ferns, lilies, and African violets.
2. Tissue culture is based on the theory of totipotency -- the ability of a cell to develop into a new plant that is identical to the original plant.
3. Advantages of tissue culture:

    a. Small amount of plant material is required
    b. Rapid multiplication in a short period of time
    c. Disease-free plants and plants with desired characteristics can be produced
4. Disadvantages:

    a. Process is labor intensive
    b. Laboratory techniques are required
5. Tissue culture requires sterile techniques. Contamination will become apparent several days after the plant tissue is placed in vitro. Note: Contaminated cultures should be disposed of properly.

6. Stages of growth:

    Stage I -- A piece of the parent plant (explant) is chosen, identified and placed in vitro that is, under "test-tube" culture conditions.

Stage II -- The new growth from stage I is divided into sections and subcultured to induce additional plants.

Stage III -- Stage II divisions are subcultured to media that will stimulate root growth.

Stage IV -- The newly rooted divisions are transferred from the test tube environment to the greenhouse. A mist system is usually used until the plant's root systems are well developed and new leaves have developed.

Summary Questions

1. List two reasons for growing plants using plant tissue culture.
2. Explain the theory of totipotency.
3. List two advantages and one disadvantage of plant tissue culture.
4. What will happen if sterile techniques are not properly used?
5. Briefly describe the four stages of plant tissue culture growth.

Assignments

Propagate a plant using a different asexual technique. (See T-3, TLA, Plants with One Parent. Introduction to Technology Syllabus). Compare this technique to tissue culture.

Materials Needed

- Obtain resources for student and teacher use.
- African Violet Tissue Culture Kit and Instructions. Carolina Biological Supply Company.
- Transparency master describing tissue culture techniques.

Outside References

Consult bibliography of this learning activity brief.

DAILY LESSON PLAN

Topic

Aseptic Technique

Syllabus Connections

T-7 How Resources are Processed by Technological Systems

HOE CORE Mod - Microbes and the Environment

Setting the Stage

In order to successfully propagate plants by means of tissue culture, proper asepsis methods must be followed.

Structure of Lesson

1. Handwashing -- explain how proper handwashing prevents the transfer of microorganisms.
2. Demonstrate handwashing technique according to the following procedure, explaining the principles involved.

    a. Assemble equipment; remove watch.
    b. Adjust the water temperature to warm (warm water promotes sudsing without injury to skin).
    c. Apply soap, wet, and lather hands well.
    d. Rub hands in a circular motion promoting friction (friction assists in removing dirt and microbes).
    e. Clean between the fingers by interlacing them (handbrush can be used if fingernails are contaminated).
    f. Hands are pointed downward while washing. (Movement in handwashing is from the cleanest (wrists) to the dirtiest areas (fingers).
    g. Rinse the hands, with hands down.
    h. Pat dry thoroughly.
    i. Turn faucets off with paper towel.

3. Have students demonstrate the procedure.
4. Explain what a microorganism is and identify requirements needed for it's growth and multiplication. Correlate to the procedure for plant tissue culture.
5. Explain and demonstrate disinfecting the work area using clean technique by means of cleansing agents such as soap and water, and disinfectants such as alcohol, according to the following procedure.

    a. Work must be done under clean conditions. Success depends upon a properly prepared clean work area and aseptic technique must be followed when called for. Student should wear short sleeves or lab coat. Keep hair covered or tied back. Do not talk or cough over work area.
    b. Locate work area.
        1. Keep area away from drafts.
        2. Close doors and windows.

3. Be aware that fans and air conditioners can stir dust and increase contamination.
4. Clean region around your work area with soap and water. Wipe down with ethanol.

c. Set up transfer case. Options are:

1. Aquarium: on its side, so opened side faces student. Clean aquarium well and wipe inside with ethanol.
2. Corrugated box: on its side, so opened side faces student. Line inside with aluminum foil. Wipe inside with ethanol.
3. Polyethylene bag: size 15" x 18". Cut unopened end. Set up materials inside.

d. Equip work area before you begin, placing items within reach.

e. Set up instruments.

1. Place forceps and scalpel in a test tube of ethanol until needed.
2. To remove ethanol, dip instruments into a tube of sterile water or dry with sterile 4" x 4" gauze.

f. Clean contaminated instruments.

1. Thoroughly wipe off plant debris on a paper towel.
2. Return instruments to ethanol for disinfection.

Precaution: During procedure, be sure that "dirty" operations are not performed over "clean" or sterile items.

6. Discuss the use of sterile water as a rinsing agent.
7. Discuss methods of proper disposal of cleaning products.
8. Explain use of autoclave or pressure cooker as sterilizers.

a. When preparing your own media, the following may be used:

1. Autoclave.
2. Pressure cooker.

b. Autoclave:

1. After preparing media, place solutions in autoclave. Follow manufacturer's instructions.
2. Allow solution to cool for 15 to 20 minutes.
3. Student should wash hands according to handwashing technique before removing the sterilized articles.

c. Pressure Cooker:

1. After preparing media, place solution in pressure cooker on rack.
2. Run pressure cooker following manufacturer's instructions.
3. Student should wash hands according to handwashing technique before removing sterilized articles.

Summary Questions

1. What is the name given to a living plant or animal that cannot be seen by the naked eye?
2. What is the purpose of using friction to wash the hands?
3. Why is it important to hold the hands lower than the elbows when washing and rinsing?
4. What is the appropriate solution to use for disinfecting the work area?
5. Name one household utensil that can be used in place of an autoclave for sterilization

Teaching Strategies:

Have students use "germ glow" when demonstrating the process.

Assignments

Practice the procedure. Read chapter in reference book on medical asepsis.

Materials Needed

Handwashing technique:

- liquid soap
- water
- handbrush
- paper towels

Disinfecting the work area:

- ethanol (70% - 90%) (alcohol)
- sterile petri dishes
- forceps
- scalpels
- sterile distilled water
- sterile gauze pads (4 x 4)
- paper towels
- wastebasket
- container to hold used scalpel blades
- transfer case (corrugated box, aquarium, or polyethylene bag)

DAILY LESSON PLAN

Topic

Media Contents and Preparation

Syllabus Connections

T-6 Choosing Appropriate Resources for Technological Systems
T-7 How Resources are Processed by Technological Systems
T-9 Technology and Society Now and in the Future

HOE CORE Mod - Microbes and the Environment

Setting the Stage

A culture medium must contain the essential macro and micronutrients in the proper balance. An energy source such as sucrose (sugar) must also be present. Media should also contain vitamins and growth stimulation. Agar is used to provide a surface for contact between the medium and the plant tissue. Sterile technique procedures must be carefully followed to insure a sterile medium.

Culture medium may be purchased in an agar suspension. After heating the medium is poured into the growth container. This is the recommended beginning procedure to use. Another procedure is to purchase commercially prepared chemicals. These are then added to distilled water and agar. The culture medium must then be autoclaved.

Structure of Lesson

1. Background: medium contents

   All plants require the six macronutrient elements: nitrogen, potassium, magnesium, calcium, sulfur, and phosphorus. Concentrations vary according to the various groups of plants.

   Seven micronutrient elements are also added in various ratios: iron, manganese, zinc, copper, boron, molybdenum, and chlorine.

   Two classes of plant hormones, are used predominantly: auxins and cytokinins.

   1. Auxins -- stimulate division and cell enlargement in existing buds
   2. Cytokinins -- promote cell division in explanted tissue and promote axillary and adventitious bud development.

   Sucrose is added for the energy source.

   Vitamins are added to promote growth. Some act as antioxidants.

2. General instructions for preparing one liter of medium from pre-packaged chemicals.

Measure out approximately 800 ml deionized/or distilled water and pour into a 2-liter flash or beaker.

The water should be at room temperature (15 - 20º C). Add the purchased powdered media to the water while gently stirring. Rinse out the package to remove all traces of residual powder.

Add sucrose (usually 30 grams) and other supplements if desired.

Stir until all components are dissolved.

When completely dissolved, use one part normal potassium hydroxide or normal hydrochloric acid to adjust the pH. A pH of 5.7 is recommended for agar cultures. Make sure the acid or base is well dispersed before testing.

Add additional water to bring the total volume to 1 liter.

Add 4 grams of agar to two clean 1000 ml flasks.

Add 500 ml of the prepared media solution to each flask.

Insert cotton into the neck of each flask loosely.

Cover cotton and neck of flask with aluminum foil.

Autoclave for 15 minutes at 15 psi (121°C or 250°F).

Summary Questions

1. Explain what techniques are utilized to maintain a sterile culture medium.
2. List the standard autoclave time, temperature, and pressure.
3. List the four basic components of culture media and describe the importance of each.

Materials Needed

Prepared culture media:

- metal pan
- petri dishes

Commercially prepared chemicals:

- distilled water
- agar
- sucrose (sugar)
- two 1000-ml flasks
- one 2-liter flask
- autoclave
- cotton
- aluminum foil

DAILY LESSON PLAN

Topic

Plant Tissue Culture Stage I (Initation Phase)

Syllabus Connections

T-3 Plants with One Parent
T-5 How Technology Affects People and the Environment
T-6 Choosing Appropriate Resources for Technological Systems
T-8 Controlling Technological Systems

HOE CORE Mod - Microbes and the Environment

Setting the Stage

Principal purpose is to establish a microbe-free explant culture with intention to initiate new growth.

Structure of Lesson

1. Choosing a plant. Three important considerations are the regenerative capacity, physiological stage, and general health of the donor plant. A young leaf should be chosen.
2. Prepare media. This should have been done in a previous lesson with the media composition matched to the type of plant being used as a donor.
3. Prepare explant. Before explants can be placed into culture, it is essential to destroy all microorganisms. Cleaning is most easily accomplished by submerging the plant part in a strong disinfectant solution for a short time and then rinsing away the toxic residue with sterile water. Sodium hypochlorite solution and ethyl alcohol at 70 to 95% are commonly used disinfectants. One part detergent added to the disinfectant will allow better penetration. After cleaning, plant parts should be thoroughly rinsed in sterile water.

   Trimming of tissue and cutting of pieces is done with sterile tools and on a clean surface. During this process frequent disinfection of dissection tools is necessary to prevent contamination.

4. Insert in media. While placing explant into the petri plate extreme care should be taken to prevent contamination. Tools should frequently be returned to alcohol. Lids should be kept on containers and only removed enough to place explant with forceps. Slight pressure should be applied to the explant to assure contact with the media.

5. Close containers. Petri plates should be closed and sealed with parafilm and labeled. Parafilm will help prevent contamination from working into the culture.

6. Incubate. Containers should be kept in a constant growth environment. Heat range from 24º to 27ºC is best. Light should be kept on the containers for 16 hours a day and should be 100 foot candles in strength. Direct sunlight must be avoided. Approximate length of time is six weeks.

Summary Questions

1. Name the cut up pieces of the plant donor to be placed in the media.
2. Why are the chemicals that make up the media important?
3. What is the principal purpose of initiating a tissue culture?
4. Why is a tissue culture used?

Assignments (Homework)

Review of all previous assignments and procedures.

Materials Needed

- multiplication medium
- razor blade of scapel
- plastic petri plates
- forceps
- ethyl alcohol
- paper towels
- parafilm
- labels
- sterile water
- sodium hypochlorite 10%
- young leaf

DAILY LESSON PLAN

Topic

Plant Tissue Culture Stage II (Multiplication Phase)

Syllabus Connections

T-3 TLA Plants with One Parent
T-5 How Technology Affects People and the Environment
T-6 Choosing Appropriate Resources for Technological Systems
T-7 How Resources are Processed
T-9 Technology and Society Now and in the Future

HOE CORE Mod - Microbes and the Environment

Setting the Stage

The main objective of stage II is the multiplication of new shoots by dividing them and placing them on a different growth medium. The second stage must be as aseptic as the first stage in preparation and implementation.

Structure of Lesson

Presentation:

1. Remove sealed petri plates from storage.
2. Open petri dishes prepared by the teacher with actively growing shoots in a disinfected area
3. Demonstrate procedure for separating the growing cultures into 2-4 pieces. Use forceps and scalpel.
4. Subculture to stage II media using sterile techniques.
5. Seal the petri dishes with laboratory parafilm tape. Date and initial for identification.

Application: Students follow teachers step by step procedure to transfer their plant material to new growing media using sterile instruments and materials.

Summary Questions

1. Why are aseptic procedures necessary during the transfer procedure of stage II?
2. Where are these same techniques and aseptic conditions used everyday?
3. What are the differences between hormones found in stage I and stage II media?
4. When should the cultures be checked for contamination?
5. What might the contamination look like?
6. How much time is necessary for multiplication to occur before the third stage?
7. If contamination has occurred, what is the recommended procedure for disposal of contaminated materials?

Assignments

Find a reference to tissue culture or animal cloning as it is taking place currently in society.

Read pages 18 - 22 of Cloning and Genetic Engineering: Social and Legal Implications. Prepare for a discussion with your neighbors and colleagues regarding these matters.

Materials Needed

- stage II media
- all equipment used in the lesson on initiating a tissue culture

DAILY LESSON PLAN

Topic

Plant Tissue Culture Stage III (Rooting Phase)

Syllabus Connections

T-3 TLA Plants with One Parent
T-5 How Technology Affects People and the Environment
T-6 Choosing Appropriate Resources for Technological Systems
T-7 How Resources are Processed
T-9 Technology and Society Now and in the Future

Setting the Stage

The main objective of stage III culture is formation of roots. The root and shoot system is necessary for the new plant to survive.

Aseptic conditions must be maintained in stage III just as they were in stages I and II.

To facilitate rooting, the hormonal composition of the culture medium must be changed. Auxins are necessary for root initiation.

The development of autotrophy (photosynthetic self-sufficiency) is necessary for the plants to grow normally. Not all the problems related to the simultaneous development of roots and leaves have been worked out at the present time.

Close attention should be given to the plants total development during this third stage.

Structure of Lesson

Presentation:

1. Follow procedures listed in stage II lesson plan.
2. Be sure that the new auxin media is prepared and ready for use.

Application:

The students will follow the procedures outlined for stage II, using stage III media.

Summary Questions

1. What hormone is used to initiate roots in stage III of plant tissue culture?
2. Describe the condition of the leaves and shoots that developed in stage II.
3. Estimate how many days it would take a seedling to achieve a stage similar to the development we find at the beginning of stage III?

Assignments

Read pages 40-48 of Cloning and Genetic Engineering: Social and Legal Implications. Prepare for a discussion with your neighbor and colleagues.

Materials Needed

- stage III media
- all equipment used in initiating a tissue culture

DAILY LESSON PLAN

Topic

Plant Tissue Culture Stage IV (Acclimation Phase) -- In the Greenhouse

Syllabus Connections

T-3 TLA Plants with One Parent
T-5 How Technology Affects People and the Environment
T-6 Choosing Appropriate Resources for Technological Systems
T-7 How Resources are Processed
T-9 Technology and Society Now and in the Future

Setting the Stage

The plants that you have been developing in the controlled conditions of the laboratory are very tender and must be treated with care. Intense light, low humidity and an unclean environment can cause as much harm to the plants as unsterile conditions in earlier stages.

Structure of Lesson

Presentation: The teacher will describe the environment for the plant growth during stage IV.

1. Present a new type of growth medium.
2. Mixture should be sterile and well moistened. A variety of pots and potting media can be used.
3. Wash off agar media from plantlets, used to grow plantlets in stage III.
4. Handle the plantlets carefully so that the roots and leaves are not damaged.
5. High moisture/humidity conditions must be maintained.

(Sealing in plastic bags for several days is highly recommended. Gradual increases in light intensity and decreases in humidity are also recommended. This can be accomplished by poking holes in the plastic bag and slowly increasing light intensity in the controlled environment.)

6. Using forceps, transfer the plants to the sterile growth medium.

Application: Students follow the procedure demonstrated by the teacher.

Summary Questions

1. How tall (long) are the plants at this time?
2. How many weeks have they been in process?
3. Why is a new growing medium needed at this time?
4. Give the contents of growing medium in stage IV.
5. What would happen if the growing medium was not moist at the time of transplanting?

Assignments

Read pages 22 - 26 of Cloning and Genetic Engineering: Social and Legal Implications.

Check out the local garden center for plants that have been reproduced by tissue culture.

Ask your nurseryperson about the cloning of plants.

Materials Needed

- variety of sterile pots and potting material
- plastic bag and ties

CAREER INFORMATION SHEET

Career Title:

Biological Sciences/Biotechnology

Description of Career Responsibilities

The biological sciences are concerned with research in the reproduction, growth and development, structure, life processes, behavior, and classification of living organisms. Also included are investigations into environmental impact, economic use of resources, and the application of findings to the prevention of disease in the maintenance and promotion of health in plant and animal life.

Representative Career Titles:

Teacher
Botanist
Naturalist
Physician
Technical writer/editor
Scientific illustrator/ photographer
Cytotechnologist
Medical, pharmaceutical, educational sales rep.
Food and drug inspector
Hematology technologist
Industrial hygienist
Microbiological technician
Museum technician
Park ranger
Biotechnologist
Plant pathologist
Biological aide
Forester
Fisheries specialists
Microbiologist
Laboratory assistant/technician
Nurse
Dentist
Veterinarian
Oceanographer
Medical record librarian
Dental/medical assistant
Biochemist
Wildlife manager
Biomedical engineer
Dietitian
Medical administrator
Optometrist
Physical therapist
Environmental technician

Educational Requirements

Preparation for most careers listed on Table I. Take as many high school science and math courses as possible -- biology, chemistry and physiology; English; and math through geometry. Have a familiarity with computers.

Skills or Personal Attributes Needed

1. Enthusiasm for science, specifically biology.
2. A capacity for intellectual growth.

3. The ability to work with great precision.
4. An inquisitive outlook or curiosity tempered with the ability to be patient.
5. Manual dexterity is a valuable asset.
6. Willingness to work with others.

Salary Level

Entry-level careers in the biological sciences start at $14,000 to $25,000 per year. With additional experience and education in this field, salaries of $75,000 and higher can be attained.

Employment Opportunities

According to the U. S. Department of Labor, employment in the biological sciences/biotechnology field is expected to grow 15 to 30 percent through the mid-1990's.

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Browse, Philip McMillan. Plant Propagation. Published in Cooperation with the Royal Horticultural Society by Simon and Schuster, Inc. New York, New York, 1978. Helpful for putting tissue culture into perspective.

Caldwell and Hegner. Health Care Assistant. Albany: Delmar Publishers, Inc., 1985.

Dixon, R. A. Plant Cell Culture: A Practical Approach. IRL Press, Washington, D. C., 1985.

MacDonald, P. Plant Cell and Tissue Culture: A Laboratory Manual. Springer-Verlag, New York, 1982.

Mantel, S. H. and H. Smith. Plant Biotechnology. Cambridge University Press, New York, 1983.

McDonald, Phyllis Parshall. Cloning and Genetic Engineering: Social and Legal Implications. Kemtec Educational Corporation, 9889 Crescent Park Drive, West Chester, Ohio 45069, 1988. Not definitive but useful for Technology Education.

Simmers, Louise. Diversified Health Occupations. Albany: Delmar Publishers, Inc., 1983.

Sources of Supply:

Plant Study Kits, Science Kit and Boreal Laboratories, Tonawanda, New York 14150.

Plant Study Kits, Carolina Biological Supply Company, Burlington, North Carolina 27215.

Plant Study Kits, Kemtec Educational Corporation, 9889 Crescent Park Drive, West Chester, Ohio 45069.

Ward's Natural Science Establishment, Inc., 5100 West Henrietta Road, Rochester, New York 14692-9012.

Outside References

Introduction to In Vitro Propagation. D. F. Wetherell, Wayne, NJ. Avery Publishing Group, Inc., 1982.

GLOSSARY

Adventitious	Development of structures from abnormal points of origin, e.g., shoots or roots from callus, shoots from leaves, embryos from sources other than zygotes.
Antiseptic	An agent which will prevent the growth or arrest the development of microorganisms, but not spores -- usually applied to living tissue.
Asepsis	A condition free of organisms.
Asexual	Reproduction of plants using vegetative plant parts propagation such as stem and leaf cuttings, rather than propagation by seed.
Auxins	A class of plant growth regulators. These hormones stimulate new cell division, cell enlargement, and the creation of adventitious buds in Stage I explants. In later stages of growth they promote rooting.
Callus	An undifferentiated growth of cells that form under the influence of high concentrations of auxins and/or cytokinins.
Clonic	Asexual reproduction of plants that are considered to be genetically uniform, and originated from a single individual or explant.
Contaminate	To soil, stain, pollute, or place in contact with microorganisms.
Cuticle	A layer of waxy substance that covers the entire epidermis of a plant and protects the tissue from excessive water loss.
Cytokinins	A class of plant growth regulators. In tissue culture work, these hormones are valued for their ability to stimulate cell division and the proliferation of shoot buds.
Disinfectant	A substance used to destroy disease producing microorganisms, but not their spores - usually applied to inanimate objects.
Distilled water	Water partially purified by converting it to steam and then condensing it in a separate container. Minerals and some organic compounds are removed by this process.
Explant	A part of an organism (usually taken from the intact, whole organism) used for in vitro culture.
Hormone	Technically, a natural chemical that exerts strong controlling effects on growth, development, or metabolism at very low concentrations, and usually at sites other than the site of synthesis.

In vitro	Literally, "in glass," e.g., a test tube.
In vitro	Propagation of plants through tissue culture propagation methods.
Medical asepsis	Rendering an object clean, e.g., handwashing.
Microorganisms	Microscopic living bodies not seen by the naked eye.
Micropropagation	Another name for "in vitro" propagation.
Pathogen	A disease-causing microorganism.
Phytohormone	The generic name of all hormones produced by plants, especially those that affect plant growth.
Plant tissue	The growth of microbe-free plant material in an cultureaseptic (sterile) environment, such as a sterilized nutrient medium in a test tube.
Stage I	Establishment of an aseptic tissue culture.
Stage II	The rapid increase "in vitro" of organs or other structures which can ultimately give rise to whole plants.
Stage III	Preparation of propagules for successful transfer to soil. A process involving rooting of shoot cuttings, hardening of plants, and initiating the change from the heterotrophic to the autotrophic state.
Stage IV	Successful establishment in soil of a tissue culture derived plant.
Sterilization	A process of destroying all life, including spores.
Subculture	Process by which the tissue or explant is first subdivided, then transferred into fresh culture medium.
Totipotency	A cell characteristic in which the potential for forming all the cell types in the adult organism is retained.