



Department of
Veterans Affairs

Supply, Processing and Distribution Training Manual



Level I: Training

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FOREWARD

A successful organization is dependent upon employees who are trained to do their jobs properly. This is the reason the SPD training and certification program were begun. The complexities of the various functions within SPD are continuously increasing making it essential that employees who work there understand what they are doing, why the established procedures are necessary, and how SPD fits into the overall process of patient care. The need for continuing education is evident by the numerous of professional organizations, instructional guides, workshops, conferences, seminars, and certification programs developed for SPD employees. This instruction manual provides a structured format for mandatory level I training in all aspects of SPD. Upon completion of the coursework, employees are encouraged to obtain their certification as a Certified Medical Supply Technician. A workforce of well trained and certified employees is the best assurance for outstanding patient care to our veterans.

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INTRODUCTION SPD

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Supply, Processing and Distribution

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OBJECTIVES

Following training, the employee will be able to:

1. Identify the main objectives of SPD.
2. Discuss the history of SPD.
3. Identify the areas of SPD and their respective functions.
4. Discuss the importance of patient confidentiality and cost containment.
5. Describe the SPD role in infection control.
6. Define: people flow, material flow, work flow, and air flow.
7. Define Universal Precautions.
8. List the safety hazards associated with SPD.
9. Define and explain RACE.
10. Explain MSDS and its use.
11. Identify regulatory agencies which affect healthcare facilities.
12. Explain the advantages of good communication.
13. Discuss the importance of a good understanding of medical/surgical terminology.

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SUPPLY, PROCESSING AND DISTRIBUTION

1. Supply, Processing and Distribution (SPD) is the central hub around which all patient care activities revolve. It is where all medical/surgical supplies and equipment are requisitioned, cleaned, processed, stored, and issued for patient use.
2. SPD's main objective is to provide centralized support to all the medical center's patient care programs, while assuring appropriate aseptic conditions, economy of operation, and consistency in processing, storing, and distribution, all under strictly controlled conditions.
3. SPD is unique in that, it not only functions as an administrative section, it also functions as a clinical one. Administratively, SPD must follow all Federal procurement regulations. Clinically, SPD is involved in facilitating quality patient care by providing the right product in the right condition at the right time.
4. During the 1940's, W.B. Underwood and John J. Perkins promoted the modern concept of centralizing supply, processing and distribution functions. Prior to this, medical and surgical supplies were processed by the individual users. Decontamination and sterilization procedures varied greatly between the users, which led to nosocomial (hospital acquired) infections. There was a tremendous duplication of equipment, effort, and supplies with this system. Underwood and Perkins' concept placed all these functions under one section of the hospital.
5. Before 1967, SPD was known as Processing and Distribution (PAD). PAD organizationally was under Nursing Service. Its function was primarily the distribution of supplies. Sterilization and instrument preparation activities were minimal. The O.R., Dental, and other services requiring sterilization performed these functions on their own. After 1967, the PAD operation was placed under the Acquisition and Materiel Management Service and renamed Supply, Processing and Distribution. With the new name came expanded responsibilities including, but not limited to, decontamination, sterile processing, and inventory management. SPD today is traditionally divided into these three areas: Decontamination, Preparation, and Inventory Management/ Distribution.
6. The Decontamination Area is responsible for cleaning and decontaminating reusable equipment, instruments, and supplies. This is accomplished by manual cleaning, or by mechanical means using items such as ultrasonic washers, glassware washers, glassware dryers, tube washers, tube dryers, flexible endoscope washers, washer/sterilizers, washer/sanitizers, cart washers, and steam guns.
7. The Preparation Area is responsible for assembling, preparing for issue, and/or sterilizing the decontaminated items. The proper assembly of materials must be

chosen, as well as the proper sterilization method. The main sterilization methods are steam and ethylene oxide (EtO).

8. The Inventory Management/Distribution Area is responsible for the requisition, issue, and maintenance of medical/surgical supplies. In addition, Distribution is usually responsible for case cart assembly, exchange cart inventory, secondary inventory, and telephone and/or call window distribution.

9. Cost containment is an issue that concerns all medical supply technicians. Waste can be reduced by the careful handling of supplies, accurate record keeping, and communicating with users to set adequate stock levels and eliminate unofficial inventories. Medical supplies and equipment are very expensive. Incidences of theft and fraud have negative impact on medical centers, are punishable by law, and should be reported immediately.

10. The medical supply technicians must be aware of their responsibility to patient confidentiality. The disclosure of a patient's medical or personal condition should never be communicated to others not directly involved. This information should be held confidential regardless of how it was obtained. Employees should not discuss these issues while at lunch, on breaks, on elevators, etc.

11. SPD is extremely instrumental to infection control in the medical center and is a member of the hospital's Infection Control Committee. Paying careful attention to personal hygiene and good health will minimize the potential for acquiring or transmitting diseases. All SPD employees must help ensure that medical supplies are decontaminated and processed under the best possible conditions for maximum safety and protection of patients, employees, and visitors. Each area within SPD has a dress code which must be strictly adhered to. The purpose of dress codes is to prevent cross-contamination, to maintain a professional appearance, and to protect the employee. In the sterile preparation area, a long sleeve scrub suit or warm-up jacket is required. Post earrings, wedding rings, and a basic watch are allowed. Necklaces are allowed but must be worn inside the scrub shirt. Artificial finger nails, excessive, overwhelming perfumes, and other jewelry are not allowed. Dedicated shoes are recommended for use in this area. When leaving the clean/sterile areas, a cover gown/lab coat is required.

12. Jewelry and artificial finger nails are not recommended in the decontamination area due to the possibility of puncturing and tearing of gloves, leading to potential exposure of the technician to contaminated blood and body fluids.

13. Traffic in SPD is restricted to authorized personnel. Anyone entering an SPD area must also follow the dress code regulations for that area. Control must also be maintained over **people flow, material flow, work flow, and air flow.**

a. **People flow** in SPD is controlled to minimize contamination due to microorganisms found on human bodies and clothing. Traffic patterns are designed so that the people flow is always directed from clean to contaminated areas.

b. **Material flow** is generally considered to be either incoming contaminated items or clean/sterile supplies. Contaminated items enter the decontamination area in covered containers/closed carts. Before leaving the decontamination area, all items are cleaned and disinfected. Clean or sterile packaged items coming into SPD will be removed from shipping and corrugated cartons before entering clean/sterile storage.

c. **Work flow** is the order in which medical/surgical items are received into SPD, processed, and dispensed for patient use without cross-contamination occurring. Contaminated reusable items are transported to the decontamination area in such a manner as to protect people and the environment from contamination. After the decontamination process, items go to the preparation area for inspection, packaging, and sterilization, as necessary, or to the equipment area. They are then transferred to the sterile storage area and maintained until issued. Work flow always goes from dirty to clean areas.

d. **Air flow** is controlled to minimize the travel of microorganisms from soiled areas to clean areas. This is accomplished by creating a positive pressure air flow in clean areas as relative to adjacent areas, and exhausting that air through the dirty areas to the outside or a filtered recirculating system.

14. The practice of Universal Precautions is followed by SPD employees, as well as all health care workers. Universal Precautions mandate that all contaminated items be treated as if they are infectious. The use of protective equipment and frequent hand washing further the infection control goals of eliminating cross-contamination in the medical center. Personal protective equipment includes impervious gowns, shoe covers, masks, gloves, goggles/face shields, and hair covering.

15. SPD has a variety of safety hazards associated with each area. With proper training and attention paid to these hazards, incidents can be kept to a minimum.

a. Environmental hazards include cuts or sticks from needles, falls from wet floors in the decontamination area, and burns from steam sterilizers in the preparation area.

b. Chemical hazards come from the many cleaners and disinfectants used in the decontamination area. Ethylene oxide is an extremely toxic, known carcinogenic gas used to sterilize many heat, liquid, or pressure-sensitive items.

c. Biological hazards arrive in the decontamination area from equipment and supplies contaminated with potentially pathogenic microorganisms.

d. Electrical hazards could include shocks from frayed or cut cords, damaged equipment, and improper cleaning of equipment.

e. Mechanical hazards usually involve equipment operation. SPD uses large automated pieces of equipment, such as automatic autoclave doors, automatic transport systems, cart washers, dumbwaiters, and elevators.

f. Physical hazards result from improper lifting, pulling, pushing, and bending.

16. All injuries sustained by SPD employees should be reported to the Chief, SPD, immediately. The employee will be sent to the Employee Health Physician for treatment and documentation. Form CA-1 and VA Form 2162 will then be completed.

17. All SPD employees, as well as all medical center employees, must be familiar with fire safety rules and procedures. The acronym **RACE** is used to define actions to be taken in the event of a fire:

R - Remove - all persons in immediate danger.

A - Alarm - activate fire alarm; dial appropriate number and inform operator where fire is located.

C - Close - all doors.

E - Extinguish - fire with extinguishers only if fire is reasonably small and can be handled alone.

18. Hazard communications are an on-going activity. SPD employees must be aware of the potentially dangerous products they use on a daily basis. A Material Safety Data Sheet (MSDS) is a document that provides information on the physical characteristics and potential health risks of a hazardous material, as well as other information, such as the chemical name, common or trade name, manufacturer, and ingredients. The MSDS also gives instructions in the event of hazardous contact with the product or a leak or spill. All hazardous material in SPD will have an MSDS on file and staff will be trained annually. A copy of the MSDS file must be accessible to all employees for easy reference. Areas where hazardous materials are utilized will have warning signs posted.

19. Many regulatory agencies, Federal, State, and local, have standards which affect health care facilities. Some of these include:

a. Occupational Safety and Health Administration (OSHA) - establishes and enforces laws governing occupational exposure to toxic chemicals, such as EtO and glutaraldehyde.

b. Environmental Protection Agency (EPA) - regulates the manufacturing, labeling, and emissions of ethylene oxide (EtO).

c. Food and Drug Administration (FDA) - regulates the manufacturing and classification of medical devices, such as infusion pumps, feeding pumps, and implantable devices.

d. Centers for Disease Control (CDC) - performs research and makes recommendations regarding infection control issues.

e. National Institute of Occupational Safety and Health (NIOSH) - performs research and makes recommendations regarding occupational safety and health issues.

20. The Joint Commission on Accreditation of Healthcare Organization (JCAHO) is a voluntary accreditation organization to which healthcare facilities may choose to belong in order to qualify for financial reimbursement from insurers. The JCAHO standards which affect SPD are infection control, safety, sterilization, quality assurance, and training.

21. Professional organizations offer recommendations and/or guidelines which impact SPD. Among those are:

- a. International Association of Hospital Central Service Personnel (IAHCSP)
- b. International Association of Hospital Central Service Material Managers (IAHCMM)
- c. Association of the Advancement of Medical Instrumentation (AAMI)
- d. Association of Operating Room Nurses (AORN)
- e. Association of Practitioners of Infection Control (APIC)
- f. American Society for Healthcare Central Service Personnel (ASHCSP)

These organizations provide enhancement of patient care by elevating the standards of SPD personnel.

22. Individual medical center policies and procedures manuals provide rules and regulations and indicate specific steps in completing tasks. These policies should be kept at hand as a reference and read by all personnel. Equipment manuals provide instructions on operation, maintenance, and troubleshooting and are readily available for reference.

23. The medical supply technician communicates daily with individuals from various backgrounds, from doctors and nurses to patients and their families. Communication is extremely important in that pertinent information is exchanged regarding patient care

needs, thus meeting the user's demands and keeping medical supply technicians up-to-date on current inventory and their specific uses. Communication is also essential within the SPD section. Good interpersonal relationship skills promote a productive work environment. Gossip, malicious talk, and rumors lead to dissension and dissatisfaction within SPD, which ultimately affects the service provided. In face-to-face meetings or phone conversations, the technician must be polite and courteous. A helpful attitude promotes good will and smoother work production.

24. Knowledge of basic medical/surgical terminology is essential for the SPD technician. Correct terminology between the technician and user will allow rapid responses to their requests. Many times when items are requested, generic or "slang" terminology is used. It is essential that the medical supply technician be familiar with the vast amount of terminology used. In instances where an unfamiliar item is requested, as much information as possible should be obtained. For example, when a catheter is requested, they may need a cardiac catheter, a Foley catheter, or a urethral catheter. A call received for an airway may indicate a need for an oral airway, nasal trumpet, or an endotracheal tube. Patient care incidents can be avoided if the medical supply technician can comprehend and correctly use medical terminology. Understanding what an item is used for, and why, will also enable the technician to obtain the item quickly and correctly. The key to understanding medical terminology is understanding the relationship between root words, prefixes, and suffixes.

25. The root word is the building block of the word. For example, the root word of dermatitis, dermatome, dermatologist, and dermatology is derma, which means skin. The prefix appears at the beginning of a word and enhances its meaning. Dispense, disinfect, disease, and disperse all have dis as their prefix. The suffix appears at the end of a word and also enhances its meaning. Cytology, biology, physiology, and cardiology all have ology as their suffix.

26. The SPD department has come a long way in the last 20 years in sophistication, skill levels required, and knowledge necessary to perform many duties adequately.

IMPORTANT TERMS - INTRODUCTION TO SPD

Air Flow
Biological Hazards
Centers for Disease Control
Chemical Hazards
Confidentiality
Electrical Hazards
Environmental Hazards
Environmental Protection Agency
Food and Drug Administration
Joint Commission on Accreditation of Healthcare Organization
Material Flow
Material Safety Data Sheet
Mechanical Hazards
National Institute of Occupational Safety and Health
Nosocomial
Occupational Safety and Health Administration
People Flow
Physical Hazards
Prefix
RACE
Suffix
Universal Precautions
Work Flow

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SPD

1. SPD is the area where medical/surgical supplies and equipment are _____, _____, _____, _____ and _____ for patient use.
2. _____ and _____ promoted the centralized sterile supply concept.
3. The decontamination area is responsible for _____ and _____ reusable equipment and supplies.
4. The main sterilization methods are _____ and _____.
5. The issue and maintenance of medical/surgical supplies occurs in the _____ area.
6. The purposes of dress codes are to prevent _____, maintain a _____ appearance, and to protect the _____.
7. Control is maintained over _____ flow, _____ flow, _____ flow, and _____ flow.
8. A needle stick represents an _____ hazard.
9. A _____ is a document accompanying hazardous materials which lists important information about that material.
10. _____ governs occupational exposure to toxic chemicals.
11. Used in the decontamination area to mechanically clean is:
 - a. ultrasonic washer
 - b. flexible endoscope washer
 - c. washer/sanitizer
 - d. all of the above
12. Treating all items as infectious is:
 - a. Paranoid
 - b. Universal Understanding
 - c. Overall Contamination
 - d. Universal Precautions
13. The "R" in the acronym RACE stands for:
 - a. Run away quickly
 - b. Remove all persons in danger
 - c. Ring the fire alarm
 - d. Respond to the evacuation team

14. An MSDS includes:
- a. chemical name
 - b. manufacturer
 - c. price
 - d. a & b
15. Which is NOT a JCAHO standard affecting SPD?
- a. hiring
 - b. sterilization
 - c. training
 - d. infection control
16. SPD's main objective is:
- a. support patient care
 - b. assure aseptic conditions
 - c. display consistency in operations
 - d. all of the above
17. Underwood and Perkins' work was documented in the:
- a. 1900's
 - b. 1940's
 - c. 1890's
 - d. 1960's
18. Which is NOT a distribution area function?
- a. issue of supplies
 - b. case cart assembly
 - c. operation of tube dryer
 - d. secondary inventory
19. "Work flow" always goes from:
- a. decontamination to preparation
 - b. soiled to clean
 - c. preparation to distribution
 - d. all of the above

MICROBIOLOGY

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Microbiology

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OBJECTIVES

Following training, the employee will be able to:

1. Define microbiology and microorganism.
2. List the four main areas of microbiology.
3. Discuss the major characteristics of bacteria and viruses.
4. Explain what endospores are and their importance to the SPD technician.
5. Discuss the four conditions necessary for disease transmission to take place.
6. Define vector and fomite and cite examples of each.
7. List the two criteria necessary for disease to develop.
8. Define nosocomial infection.
9. Explain the importance of hand washing and list the situations when hands should be washed.
10. Explain the concept of universal precautions and the blood borne pathogens standard.
11. Define disinfection and list the three levels of disinfection.
12. Define sterilization and explain the process of sterilization.

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MICROBIOLOGY AND INFECTION CONTROL

1. It is imperative that an SPD technician understand what microorganisms are so they can be effectively controlled, contained, and killed. SPD's objectives are to provide centralized supply support of the medical center's patient care programs, while assuring appropriate aseptic conditions, economy of operation, and consistency in processing, storing and distribution, all under strictly controlled conditions. In order to accomplish these objectives, SPD functions to control the number of microorganisms present on medical supplies, instruments, and equipment.

2. MICROBIOLOGY

a. Microorganisms have been around since the beginning of time. However, it was not until the late 1600's that they were seen by the human eye and acknowledged as an entity. Antonj van Leeuwenhoek, a Dutch linen draper, was able to observe different forms of bacteria through his invention, the microscope. It was not until the end of the nineteenth century that the work of Louis Pasteur led to the development of the science of microbiology. Joseph Lister, an English surgeon, expounded on Pasteur's experiments and was able to formulate principles of aseptic technique. His work involving aseptic technique led him to be known as the "Father of Antiseptic Surgery."

b. Microbiology is the branch of biology that studies microbes. Microbes are tiny microorganisms containing one cell. Some of these microorganisms are harmful, but many are not. Because the number and characteristics of microbes varies so much, the study of these microorganisms has been specialized over the years. These areas include, but are not limited to, bacteriology -- the study of bacteria, virology -- the study of viruses, protozoology -- the study of protozoa, and mycology -- the study of fungi.

3. BACTERIA

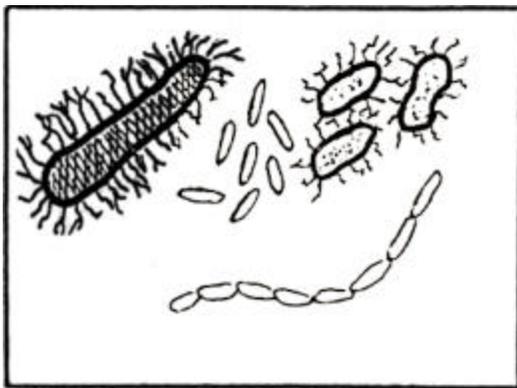
a. Bacteria are probably the most versatile of the microorganisms, being able to function in a variety of conditions. They are composed of only one cell and range between 0.4 and 2 micrometers in size. Although they lack a distinct nucleus and some don't contain a cell wall, most bacteria contain the systems and genetic material which are necessary for growth and reproduction. Locomotion is possible in some bacteria through the use of single-filament flagella. Oxygen also plays a significant role in the growth of bacteria. Anaerobes grow only in the absence of oxygen; oxygen is toxic to these microbes. Aerobic bacteria are those organisms that require oxygen for growth. Some bacteria, whether anaerobic or aerobic, can grow with varying levels of oxygen present. The shapes that bacteria can appear vary between the spherical cocci, rodlike bacilli, or spiral forms.

b. Bacteria may be useful or harmful, depending on where they are isolated. Bacteria that cause fermentation in the making of buttermilk, cheese, vinegar, and

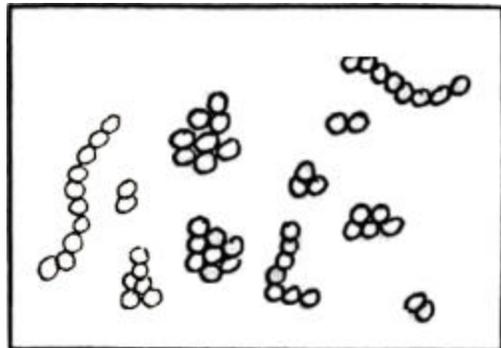
alcohol are useful. Some bacteria live in the digestive tract of humans and animals aiding in food digestion. E. Coli is an example of one of approximately 50 bacteria found in the colon. However, if E. Coli gains access to the urinary tract, infection may ensue. Useful bacteria are more numerous than harmful. Harmful bacteria will sour milk and make butter rancid. Bacteria may cause infections resulting in discomfort, severe illness, and even death. Some of the most commonly recognized diseases caused by bacteria include boils, sore throat, whooping cough, blood poisoning, diphtheria, gonorrhea, meningitis, and pneumonia.

4. GRAM STAIN

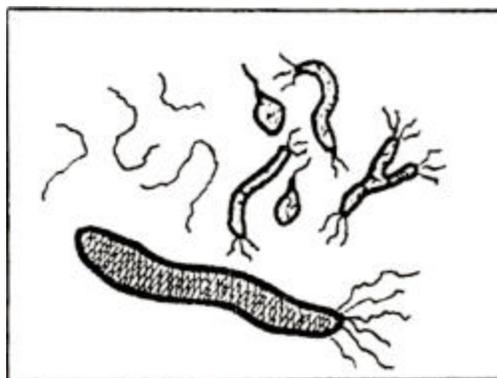
Bacteria are often classified by their Gram staining properties. The Gram stain was formulated early in the 1800's by Christian Gram as a means to identify organisms. Organisms, which are said to be Gram-positive, will stain blue; those that are Gram-negative will have a red stain.



Bacilli



Coci



Spirilla

Gram Stain

5. ENDOSPORES

When conditions exist which are harmful to the cell, certain bacteria are able to protect themselves by forming endospores (spores). As the environment begins to change around the cell, a heat-resistant, nongrowing structure forms within the cell. This is the endospore. Its ability to survive exposure to chemicals and disinfectants, heat, freezing, and radiation is increased dramatically. When conditions return to those in which the cell can grow, the spore reverts to its viable state. The survivability of endospores is well-documented. Some spores can survive exposure to liquid nitrogen (-190 degrees C) for half a year. Spores were found in the pyramids of Egypt. After returning them to favorable environmental conditions, the spores were able to return to their viable state. As these examples clearly indicate, it is imperative that methods be devised and used to ensure endospores are killed in the decontamination and sterilizing cycles of SPD. Spores, being the most difficult microorganisms to kill, are used to challenge the sterilizer function to assure a kill rate is achieved. Spore-forming bacterial infections include anthrax, botulism, gas gangrene, and tetanus.

6. VIRUSES

Viruses are the smallest and most primitive of infectious agents. Research into viruses is still limited. There are many things we still need to know about viruses in order to understand how they produce disease. In fact, most cannot be seen with an ordinary microscope. They can range in size from 20-300 nanometers. Viruses have the ability to reproduce rapidly. However, viruses are inactive outside of a host body and can only reproduce while in a living cell. A number of human diseases are caused by viruses, including chickenpox, measles, polio-myelitis, influenza, rabies, hepatitis B, and AIDS.

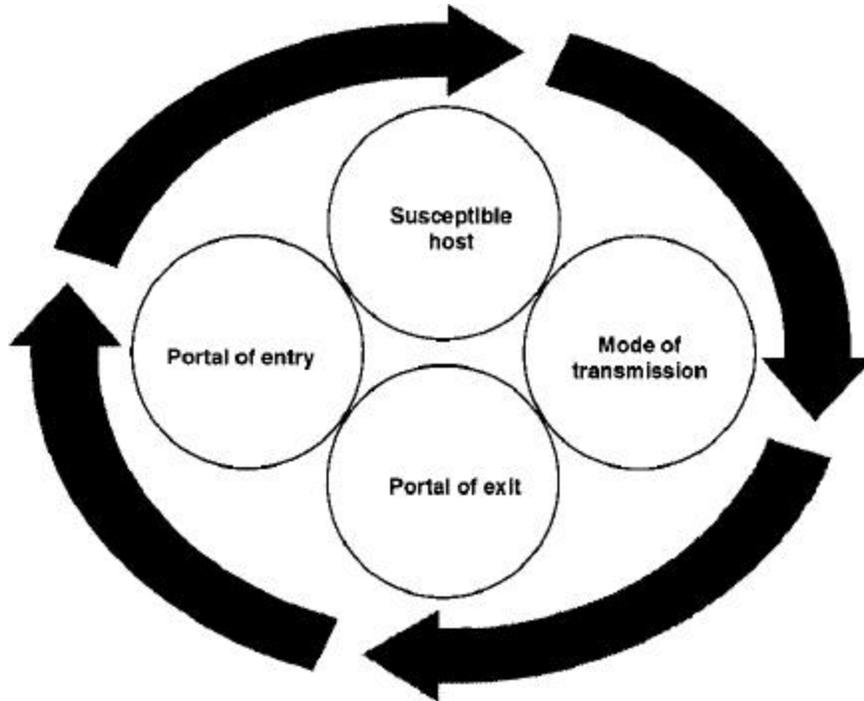
7. PROTOZOA

Protozoa are classified as parasites. A parasite is an organism that must live within or on other living organisms in order to survive. They draw nourishment from their host organism. Protozoa range in size from 1 micrometer to 50 millimeters or more. Being a self-contained unit, protozoa are considered to be the lowest form of animal life. Examples of diseases caused by protozoa are malaria and amebic dysentery.

8. FUNGI

Fungi may be the most familiar family of microorganisms. They appear in two major forms: molds and yeasts. Although there are numerous species of fungi (100,000), only a fraction of these (about 100) can be related to diseases in humans and animals. Fungi are larger than bacteria. They can be composed of a single cell, as small as 2 micrometers, or multicellular colonies which are visible to the naked eye. Fungal cells are composed of a nucleus, nuclear membrane, and a rigid cell wall and, in many ways, resemble cells of higher plants and animals. Unlike those of the plant kingdom, fungal

COMPONENTS OF THE INFECTIOUS DISEASE PROCESS (CHAIN OF INFECTION)



1. Portal of exit of the agent.
2. Mode of transmission of the agent.
3. Portal of entry into host.
4. Susceptible host.

cells are unable to produce their own food through photosynthesis. Lacking this ability requires them to live as parasites or saprophytes, drawing nutrients from other living or decaying organisms. Because of this, fungi are most commonly found in water, soil, and decaying organic matter. Molds can cause diseases, such as athlete's foot and ringworm. Yeasts can cause diseases of the skin, mouth, and genitals. Not all fungi are harmful. The antibiotic penicillin is a derivative of the fungi mold. Some fungi are also used in the production of foods, such as cheese.

9. DISEASE TRANSMISSION

It is the job of SPD to minimize or eliminate the possibility of any patient or employee acquiring an infection or disease from the use of any patient care equipment, instrument, or medical product by means of decontamination and sterilization. Disease transmission can only occur if four conditions exist: there is a portal of exit, pathway of transmission, portal of entry, and the new host is susceptible to infection. If any of these factors are not present, transmission of disease cannot take place. Therefore, one need only interrupt the flow of the disease transmission process at any point in order to prevent acquiring the pathogen. See illustration.

10. PORTAL OF EXIT

Pathogenic, or disease producing, microorganisms generally have specific departure paths from the host body. For many pathogens, this path runs either through the respiratory tract (mouth, nose), alimentary tract, or genitourinary tract (feces, urine). Pathogens can also exit the body in the blood, as is the case with HIV and hepatitis B and other blood borne pathogens.

11. PATHWAY OF TRANSMISSION

Pathogens are normally transmitted by either direct or indirect contact. Direct contact between persons is the most common mode of disease transmission. However, indirect transmission also occurs in the forms of airborne particles, vectors, and fomites. Airborne particles are cast off by persons when they sneeze, cough, laugh, or even during normal conversation. These particles can be carried for great distances and usually enter the noninfected host through the respiratory tract. Vectors are living organisms, such as mosquitoes, rats, and flies, that transport infectious organisms between hosts. For instance, typhoid fever is transferred by flies from the feces of patients to the food that is eaten by otherwise healthy recipients. Fomites are inanimate objects responsible for the spread of infection. Bedding, drinking cups, or patient care equipment could all be potential carriers of infection from one person to another in a hospital setting.

12. PORTAL OF ENTRY

Just as pathogenic microorganisms usually have specific portals of exit, they also invade the body through specific portals of entry. The most common portals of entry include the respiratory tract, alimentary tract, genitourinary system, and skin. Most pathogens can only produce disease if they enter the body through a specific avenue. For instance, the typhoid bacteria will only cause disease if ingested in the stomach. However, although the primary disease may not manifest itself when introduced into the body by an alternate entry point, a secondary infection may occur.

13. SUSCEPTIBILITY OF THE HOST/PROBABILITY OF INFECTION

a. Even when microorganisms are successful in entering a host body, a disease may not develop unless two criteria are met: the host is susceptible to the disease and the pathogens are present in sufficient numbers to cause the disease.

b. There are many factors which affect how susceptible a host is to the invasion of a pathogenic organism. The general health of the host is an important factor. Good nutrition, exercise, rest, and personal hygiene all help to fight off disease. Those who are more susceptible to infection are the very young and the very old. Also vulnerable are those whose immune systems are already compromised, such as persons with HIV, cancer, or who are taking immuno-suppressive medications.

c. If the host is not found to be susceptible to infection from the microbe, the organism will simply die. However, if the microbe found a suitable portal of entry, infection will not take place unless the microorganism is present in sufficient numbers to overcome the body's defense mechanisms. Only then will disease be produced in the host. Unbroken skin acts as a barrier to bacteria. In the stomach, acidic secretions destroy many microorganisms. In the blood, white blood cells attack and destroy bacteria. The lymphatic system is responsible for making lymphocytes that help the human body fight disease and produce antibodies.

14. NOSOCOMIAL INFECTIONS AND CROSS-CONTAMINATION

a. Nosocomial, or hospital acquired, infections are infections that a patient acquires while in the hospital. Although only a small percentage of patients entering hospitals develop nosocomial infections (approximately 3-5 percent), the additional expenses incurred in treating these patients amounts to more than one billion dollars each year (Center for Disease Control). SPD plays a significant role in preventing these infections due to the nature of the work that we do. In every instrument set that is decontaminated and sterilized, and every piece of patient care equipment that is disinfected and reissued, lies the possibility of a veteran developing complications due to cross-contamination. In order to eliminate this possibility, SPD must break the disease transmission cycle through the use of proper infection control procedures and good common sense.

b. At the very foundation of SPD lies several principles and procedures that have been developed to interrupt the transmission of infection and disease between patients and employees.

15. HAND WASHING

a. An important, but often overlooked, step in the battle against nosocomial infections and cross-contamination is simple hand washing. Hand washing is the single most important procedure for preventing nosocomial infections. The Center for Disease Control defines hand washing as a "vigorous, brief rubbing together of all surfaces of lathered hands, followed by rinsing under a stream of water." After hands are washed, use a paper towel to turn off the water to prevent recontamination of the hands.

b. SPD technicians must be sure to wash their hands frequently and thoroughly to prevent cross-contamination and the spread of nosocomial infections. Hands should always be washed immediately if contaminated with blood or other body fluids and after gloves are removed. In addition, employees must wash their hands before going on duty, before and after meals, after using the bathroom, after handling soiled items, before entering the clean area or handling clean items, and before going off duty.

16. UNIVERSAL PRECAUTIONS

In the past, personnel exposures to individual cases of diseases and infections were controlled through the use of isolation techniques. These specified what type of personal protective equipment and aseptic techniques were necessary in different situations. Since then, the different types of isolation have been replaced by the concept of Universal Precautions, as recommended by the Centers for Disease Control (CDC). This means that all blood and body fluids are considered to be potentially infectious, which necessitates the utilization of personal protective clothing and equipment by the SPD technician. In 1990, OSHA also published the blood borne pathogen standard, which required employers to take the necessary steps to reduce the potential for exposure to pathogens occurring under normal working conditions. The goal is to prevent any blood or other infectious materials from reaching any employee's skin, eyes, mouth, or other mucous membranes which may serve as a portal of entry. In compliance with the blood borne pathogen standard, each SPD technician is offered the Hepatitis B vaccine series at no charge. If the vaccine is refused by the employees, they are required to sign a declination statement, which is kept in their health records. The employees can, at any time, change their minds and decide to accept the vaccination. The Hepatitis B vaccine is recommended for anyone who may, through the course of their duties, come into contact with blood or body fluid. It is strongly recommended that medical supply technicians receive the hepatitis B vaccine.

17. DISINFECTION PRINCIPLES

Many items used to deliver patient care cannot be sterilized. These items are rendered safe for use by subjecting them to a chemical disinfectant. Disinfection is the process by which some, but not all, pathogenic microorganisms are destroyed. Disinfectants are agents used on inanimate objects. Chemical agents used to kill microbes on living tissue, such as the hands, are called antiseptics. Disinfectants are commonly referred to in terms of their efficacy, i.e., high-, medium-, or low-level disinfectants. High-level disinfectants will kill most microorganisms, but not bacterial spores. Medium-level disinfectants are effective against many bacteria and viruses, but are ineffective against some and will not kill spores. Low-level disinfectants are effective only against some bacteria and viruses.

18. STERILIZATION PRINCIPLES

a. Any item that will penetrate a mucous membrane or skin must be subjected to a process that will eliminate all forms of microbial life on that item. That process is known as sterilization. Sterilization is a process that destroys all microorganisms, including endospores, that are present on an object. The term *sterile* is an absolute term; either an item is sterile or it is not. In SPD, sterilization is normally accomplished by utilizing one of two methods: saturated steam under pressure or ethylene oxide (EtO). Two other methods, dry heat and chemical sterilization, exist but are rarely used for terminal sterilization in VA.

b. In order to assist in the process of sterilization, it is important that the bioburden, or amount of microorganisms present, is reduced as much as possible. That is why each item must go through the process of decontamination before being sterilized. In addition to reducing the amount of bioburden on an object, the decontamination process will also remove any debris, which may lead to infection if left in or on a patient.

c. Sterilization is not an exact science. There is no known way to prove an item is sterile because as soon as the package is opened, it is subject to contamination by airborne microorganisms. What we do in SPD is provide the procedures and processes necessary to maintain a high probability that the item is sterile when it is issued. Evidence, in the form of chemical, biological, and mechanical indicators, is gathered daily to help assure this is so.

Microbiology Terms

Aerobes
Anaerobes
Antiseptic
Bacteria
Bacteriology
Bioburden
Blood borne Pathogen
CDC
Disinfectant
Disinfection
Endospore
Fomite
Fungi
Gram Stain
High-level Disinfectant
Low-level Disinfectant
Medium-level Disinfectant
Microbes
Microbiology
Mycology
Nosocomial Infection
Pathogen
Protozoology
Sterile
Sterilization
Vector
Virology
Virus
Universal Precautions

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MICROBIOLOGY

1. Microbiology is:
 - a. the branch of biology that studies diseases in man.
 - b. the study of how plants grow.
 - c. the branch of biology that studies microbes.
 - d. the branch of biology that studies small animals.

2. A microbe is a microorganism which:
 - a. contains only one cell.
 - b. causes infection and disease.
 - c. contains one or more cells.
 - d. contains one cell but no nucleus.
 - e. contains one or more cells without nucleuses.

3. Bacteria may appear in three shapes. They are:
 - a. rod-like bacilli, spiral, and cylindrical.
 - b. circle, square, and line.
 - c. spherical cocci, rod-like bacilli, and spiral.
 - d. spherical cocci, rod-like bacilli, and straight.

4. The method developed in the 1800's used to identify bacteria is:
 - a. the bacteria stain
 - b. by name.
 - c. the Gram stain.
 - d. both b. and c.

5. An endospore (spore) is:
 - a. a type of bacteria that can only reproduce in the presence of oxygen.
 - b. the smallest type of bacteria.
 - c. a protective, heat-resistant, non-growing form of bacteria.
 - d. both a. and b.

6. Viruses are:
 - a. the smallest of the infectious microorganisms.
 - b. inactive outside of a host body.
 - c. able to reproduce only while in a living cell.
 - d. all the above.

7. Protozoa:
- are the lowest form of animal life.
 - are the only disease producing viruses which affect man.
 - must live within or on other living organisms to survive.
 - both a. and c.
8. Disease transmission can only occur if:
- there is a portal of exit, pathway of transmission, and portal of entry.
 - there is a portal of exit, pathway of transmission, portal of entry, and the host is susceptible to infection.
9. The most common mode of disease transmission is through:
- sharing handkerchiefs.
 - coughing.
 - insects.
 - direct contact between persons.
10. A vector is:
- an inanimate object that is responsible for the spread of infection.
 - a straight line drawn between two points.
 - a living organism that transports infectious organisms between parties.
 - an airborne particle cast off by a person when they sneeze, cough, laugh, or talk.
11. A fomite is:
- an inanimate object that is responsible for the spread of infection.
 - a small insect which is responsible for the spread of rubella.
 - a living organism that transports infectious organisms between parties.
 - an airborne particle cast off by a person when they sneeze, cough, laugh, or talk.
12. Pathogenic microorganisms usually have specific portals of entry into and exits out of the body.
- True
 - False

13. After entering the body, a disease may not develop unless:
- the portal of exit is closed off.
 - the microorganism is present in sufficient numbers to cause the disease.
 - the person is susceptible to the disease.
 - both b. and c.
14. Susceptibility to infection is greatest in:
- the old.
 - those whose systems are worn down with other infections.
 - the young.
 - all the above.
15. A nosocomial infection is:
- an infection that occurs as a result of surgery.
 - an inexpensive infection that is normally contracted during a hospital stay.
 - preventable only by eating all your vegetables.
 - an infection that a patient contracted while in the hospital that he/she did not have before being admitted.
16. The single most important procedure for preventing nosocomial infections is:
- doing your job right.
 - washing your hands.
 - don't go into the hospital.
 - don't touch anything.
17. Universal precautions refer to:
- the concept that unsafe conditions can be found anywhere.
 - the concept that only blood should be considered potentially infectious.
 - isolation techniques used with specific cases of diseases and infections.
 - the concept that all blood and body fluids are handled as if they were infectious.
18. The goal of OSHA's blood borne pathogen standard is:
- to prevent any contact with blood or other infectious materials under normal working conditions.
 - to prevent any blood or other infectious material from reaching any employee's skin, eyes, mouth, or other mucous membrane.
 - to have a present in the hospital.
 - to standardize dress attire in the medical center.

TRUE/FALSE

19. Bacteria absorb food from their environment directly through their cell wall.
20. Some forms of bacteria grow best where there is no free oxygen.
21. Viruses are found in one of three shapes: spiracle, rod-shaped, or spiral-shaped.

MATCH

- | | |
|---|------------------|
| 22. _____ Minute, single cell organisms that grow in pairs, chains, or clusters and are generally found in one of three shapes. | A. bacteria |
| 23. _____ In general, they may be classified into one of three levels: high, medium, or low. | B. viruses |
| 24. _____ The microorganism responsible for such diseases as chicken pox, measles, and AIDS. | C. disinfectants |

DECONTAMINATION

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Decontamination



Receiving Case Cart

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OBJECTIVES

Following training, the employee will be able to:

1. Define the mission of the Decontamination Area.
2. Name the items that are considered Personal Protective Equipment.
3. Discuss the importance of hand washing.
4. Identify when hands should be washed.
5. List the accepted containers to transport soiled supplies and instrumentation.
6. Describe the purpose of detergents and disinfectants.
7. Describe in brief the purpose of:
 - * washer/sterilizer
 - * washer/sanitizer
 - * cart washer
 - * ultrasonic washer
 - * pasteurmatic washer
 - * scope washer
 - * tube dryer
8. Discuss the importance of Universal Precautions.
9. List types of safety hazards that may exist in the Decontamination Area.

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DECONTAMINATION

1. INTRODUCTION

a. One of the primary concerns of a medical facility is infection control. The medical center staff must follow all precautionary steps to minimize the spread of pathogens from one patient to another. The supplies, instrumentation, and equipment they use must be clean and/or sterile. Important aspects of infection control are the processes by which instruments and equipment are collected, processed, and handled.

b. Decontamination is the process of cleaning and disinfecting medical supplies and equipment. The decontamination area of your medical center is where this process should take place. It is designed to isolate soiled items during processing. Personnel, who work in this area, are trained in the various methods of processing medical supplies and equipment for sterilization. The decontamination process plays a vital role in interrupting the transmission of infectious disease.

2. DESCRIPTION OF THE DECONTAMINATION AREA

a. The decontamination area of SPD is a restricted area specifically designed to meet the medical center's needs for the reprocessing of supplies and equipment. The area should be physically separated. Supplies and equipment should be transported to the decontamination area in impervious bags, covered/closed carts, cart lifts, dumbwaiters, and automated transport systems. The area should have adequate lighting to allow for inspection of articles during processing. Ventilation should be under negative pressure allowing air to be pulled from areas outside of decontamination. Correct ventilation is essential to reduce cross-contamination into surrounding areas.

b. The decontamination area is designed for and constructed with finished surfaces. These surfaces must withstand daily cleaning with a disinfectant to reduce the bioburden or microorganism count in the area. Personal protective equipment (PPE) is essential to an SPD technician's safety. Protective attire must be donned before entering the decontamination area. Ideally, an area should be available immediately outside the decontamination area for this purpose. It is the technician's responsibility to understand the policies and procedures regarding protective attire in their work area or job assignment. Work flow should originate from outside the decontamination area and travel inside through a dedicated entry way and/or dumbwaiter/lift system. Articles are then processed and passed through to the clean side for further preparation and redistribution.

3. PERSONAL PROTECTIVE EQUIPMENT (PPE)

a. Since the introduction of Universal Precautions, all used equipment and supplies are considered contaminated and treated as such. It is the medical center's responsibility to provide healthcare workers with PPE and training to promote personal safety. The type of PPE used in SPD includes surgical scrub suits, surgical hair covers, impervious gown and shoe covers, face mask and goggles or face shield, and designated decontamination gloves (not exam gloves). Additional protective items include plastic aprons and ear protection. Eye protection must be worn when working with liquids because splashing may occur. Ear protection may be necessary when some decontamination equipment is in use.



PPE Attire

b. Personal protective equipment must be worn at all times in the decontamination area and must be removed whenever the technician leaves the area. After removing protective wear, the technicians must wash their hands. A fresh set of protective wear must be donned before reentering the decontamination room. Regular laundering and/or disinfection of all reusable personal protective equipment is required to reduce cross-contamination. The items should be stored in an area away from contaminated equipment. A shower is highly recommended at the completion of duties in decontamination.

4. MECHANICAL EQUIPMENT PROCESSING

a. There is a wide variety of processing equipment available for use in the decontamination area. The type of equipment used will depend on the items to be processed. Each piece of equipment is designed to process a selected group of instrumentation and/or equipment. The various types include: washer/sterilizer, washer/sanitizer, utensil washer, ultrasonic cleaner, tube washer, pasteurizer, scope washer, cart washer, hand operated steam cleaning device, and tube dryer.

b. Washer/Sterilizer

(1) This unit is designed to clean and sterilize. This is a gravity type unit that can be programmed to wash, sterilize (steam under pressure), or a combination of the two. Generally the phases of the wash/sterilize cycle are wash, rinse, sterilize, and exhaust. Types of items that can be processed through a washer/sterilizer include: metalware, respiratory tubing, surgical instruments, and glassware. Only items specifically designed to be washed/sterilized should be put through the washer/sterilizer.



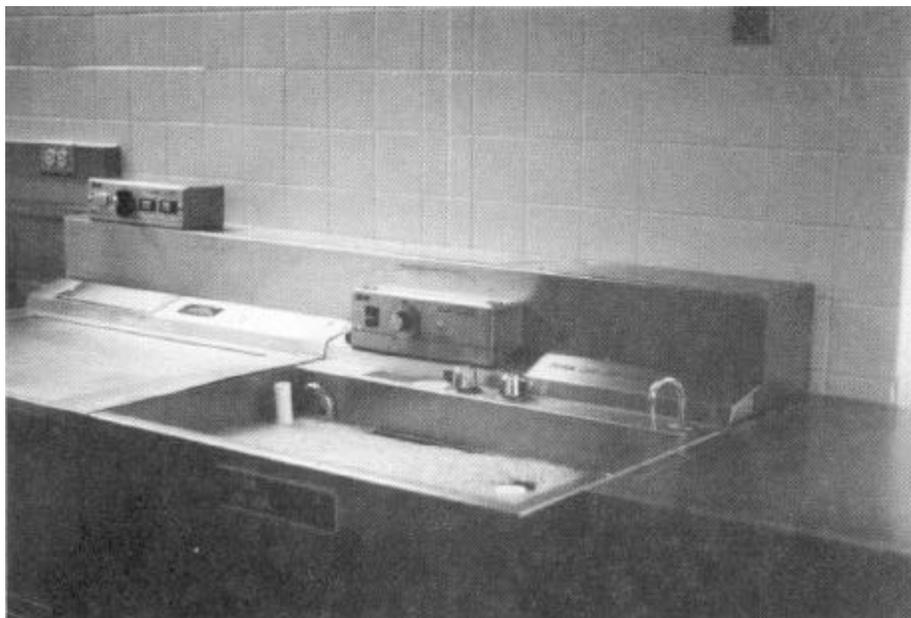
Washer/sterilizer

(2) During the cycling process technicians should periodically check monitoring displays or chart to ensure that the machine is functioning properly. A machine that does not perform up to standard will not properly process the load.

c. **Washer/Sanitizer.** This unit is designed to wash and sanitize. For the sanitizing process, hot water or steam at atmospheric pressure is used to sanitize the load. Sanitization is less effective in killing microorganisms than a washer/sterilizer.

d. **Utensil Washer.** This unit is designed to clean metalware, instrumentation, and glassware. In general, the cycle includes a wash and a rinse. Depending on the type of machine, other options could be prerinse and special rinses, such as deionized or distilled water. Only items designed for this unit should be processed through it. The items should be inspected following the cycle to ensure that they are clean.

e. **Ultrasonic Cleaner.** The unit is designed to clean surgical instrumentation utilizing ultrasonic energy in a heated water-detergent solution. Instruments which appear clean after hand scrubbing may still retain particles and other soil in the box locks, serrations, or any other difficult to clean surface of an instrument. Understanding some of the technology involved with the operation of the ultrasonic is helpful. This unit converts sound waves into vibrations that remove residual soil from instruments. Microscopic bubbles are formed on the instruments and minute vacuum areas are created as the bubbles implode. This action draws out minute particles of debris from the instruments. The process is called cavitation. Rubber and plastic items should not be used in the ultrasonic due to their tendency to absorb sound waves and defeat the process.



Ultrasonic Cleaner)

f. **Pasteurmatic Washer.** This unit is used to clean and disinfect plastic/rubber tubing and similar items. Pasteurization occurs using hot water at 170 degrees F (76.7 degrees C) for 30 minutes. This process is not effective against spore-forming bacteria.

g. **Scope Washer.** The scope washer is a machine used to automatically clean and disinfect flexible endoscopes. Depending on the unit, there may be several options which include wash only, disinfect only, or a combination. The scope requires a few preparatory steps which include manual brushing of the channels, leak testing to assure that the scope has not been perforated during use, manual cleaning of the outside of the scope. Once these steps have been accomplished, the scope is placed in the washer and an adapter is attached to the appropriate channels of the scope. In general, a detergent solution is forced through the channels of the scope followed by a water rinse. A disinfectant is then injected into the channels and the scope is bathed in a disinfectant solution for a predetermined time. This is followed by a water rinse and drying cycle. Once the scope is removed from the washer, alcohol and air may be pulled through the channels to aid drying. Before operating the unit, the technician should review the manufacturer's operating instructions.



Scope Washer

h. **Cart Washer.** This unit is used to clean items such as carts, wheel chairs, litters/stretchers, and metal pan ware. In general, the cart washer cycle consists of

a water/detergent phase followed by a water rinse. Cart washers can also be equipped with drying vents or a separate drying chamber.

i. **Steam Cleaning Device.** This is a hand held device (commonly called a steam gun) utilized for sanitizing items such as wheelchairs, litters, and carts. Steam cleaning devices can come equipped with detergent dispensers and water rinse options. Technicians should use caution when using this device. Splashing or burns may occur if personal protective equipment is not used.

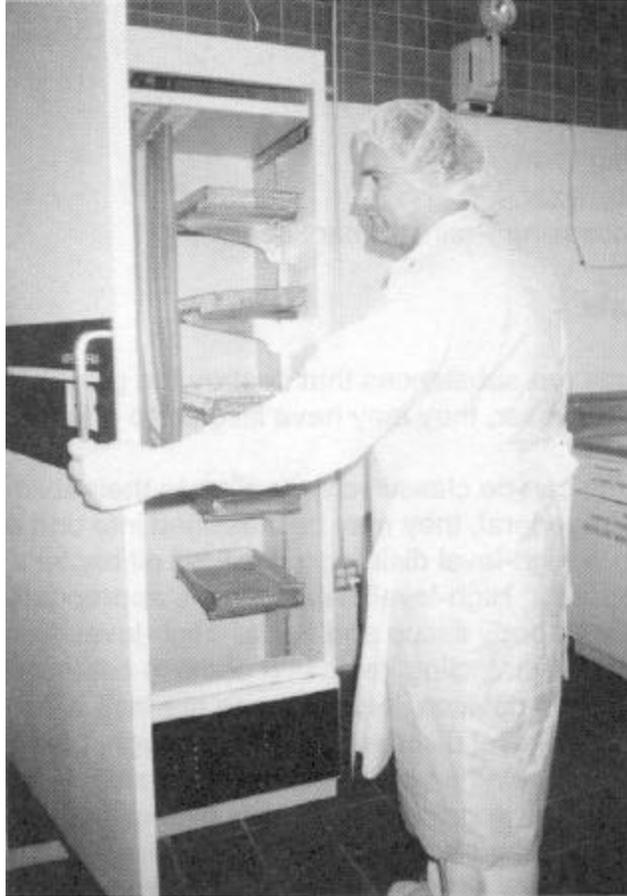


Cart Washer

j. **Tube Dryer.** This unit is used to dry plastic/rubber goods following cleaning and disinfection. The unit draws in air and heats it. The hot air is then circulated into the cabinet. This facilitates drying the load. Following the cycle, the technician should check the items to ensure they are completely dry. Items that are not dried correctly may interfere with further thermal or EtO sterilization.

5. DETERGENTS AND DISINFECTANTS

a. Detergents and disinfectants are the chemical agents used with manual and mechanical processing of instruments and equipment. Proper use of these agents helps reduce the number of microorganisms to a level that makes items safer to handle.



Tube Dryer

b. Detergents

(1) Detergents are used to aid in the removal of soil such as blood, pus, bone fragments, and urine from the surface of instruments or equipment. Soil gives the microorganism a place to live and colonize (grow in numbers). Instrumentation and equipment not properly cleaned will continue to afford sustenance to the contaminant and may impede the disinfection and/or sterilization process.

(2) Detergents are utilized in both manual and mechanical processes of decontamination. They are normally chosen according to a pH level. A level of 7.0 is neutral. Any pH level below 7.0 is acidic. For example, blood, vinegar, and lemon juice are highly acidic. Acidic detergents can lead to rust and corrosion of instruments. Any pH level above 7.0 is alkaline. Most detergents and soaps are alkaline compounds.

(3) Detergents are used with:

- (a) Ultrasonic.
- (b) Pasteurmatic Washer.
- (c) Cart Washer.
- (d) Washer/Sanitizer.
- (e) Washer/Sterilizer.
- (f) Manual Processing/Preinstrument soak.

c. **Disinfectants**

(1) Disinfectants are substances that destroy the growth of pathogenic microorganisms. However, they may have little or no effect on bacterial spores.

(2) Disinfectants can be classified according to their ability to kill microorganisms. In general, they may be classified into one of three levels: high, medium, and low. A high-level disinfectant will kill all bacteria, viruses, and fungi, but not bacterial spores. High-level disinfection is appropriate for items that have come into contact with body tissue and fluids. High-level disinfection is also an appropriate means of disinfecting items that come in contact with mucous membranes (respiratory devices, laryngoscope blades). If the object remains in contact with some high-level disinfectants long enough, bacterial spores can be killed. For example, soaking an instrument in glutaraldehyde for a minimum of 10 hours will kill bacterial spores. Some other examples of chemical disinfectants include chlorine dioxide, hydrogen peroxide, and peracetic acid-based formulation. Medium-level disinfectants kill most pathogenic microorganisms and some viruses. They do not kill bacterial spores. Medium-level disinfection is appropriate for use on I.V. pumps, feeding pumps, etc. They are effective in killing such organisms as mycobacterium tuberculosis fungi, hepatitis B virus, medium and small size viruses. Examples of solutions include chlorine compounds, alcohols (70 percent to 90 percent ethanol or isopropyl), and some phenolic and iodophor compounds. Low-level disinfectants kill some types of bacteria. They generally have little effect on viruses and do not kill spores. Low-level disinfectants are only appropriate for use in cleaning environmental surfaces, such as table tops, floors, and walls. A disinfectant or detergent should always be used for what it was intended. If used properly, the solution will be able to perform effectively. SPD technicians must be familiar with the manufacturer's instructions for use of the chemicals.

6. SYSTEMS FOR COLLECTION AND TRANSPORT OF SOILED INSTRUMENTS AND SMALL EQUIPMENT

a. **Solid Containers.** Solid containers provide an excellent barrier to cross-contamination, as well as protection for the SPD technician. The container should be light weight, durable, and made of material that can be properly decontaminated. The container should come with a lid that fits snugly over its opening. If the container does

not have a lid, then it should be lined with a plastic bag. The bag must be sealed at the time of soiled pickup.

b. **Carts.** Carts used for soiled collection and transport should be enclosed. The cart should be easy to maneuver and decontaminate. Carts require regular maintenance; of particular importance are the wheels. Wheels must have routine lubrication to keep them moving freely and to avoid freeze up, which may occur due to repeated decontamination processing. A combination of a cart and a container is often used for soiled pickup.

c. **Automated Transport Systems.** Types of systems available include monorails and robotic transport. The principle of operation for the two systems is similar. The robotic transport is the newer of the two systems. Components consist of an enclosed cart, guide track, programmable robot, and dedicated elevator(s). The technician can program the robot to retrieve a cart from a designated area. The robot travels to a designated area, automatically loads the waiting cart, and automatically returns it to the SPD decontamination area.

d. **Dedicated Lifts/Dumbwaiters.** These provide a system for delivery of contaminated supplies to SPD. They reduce handling and provide a direct link between the user area and SPD. They should be disinfected on a regular basis, and care must also be taken that cross-contamination does not occur.

7. SOILED SUPPLY COLLECTION PROCEDURES

a. One of SPD's primary functions is the collection of contaminated supplies and equipment. All contaminated supplies and equipment should be collected in covered conveyances or containers, such as waterproof plastic bags, tote-boxes with lids, or closed or covered carts. Collection containers for holding soiled reusable supplies should be made of material that can be properly decontaminated or disposed of. Personnel involved in collecting contaminated supplies and equipment should wear protective clothing. Care must also be taken to protect the environment when transporting contaminated items to SPD. All nursing units and clinic areas should have a dedicated soiled utility or "dirty" room. Enclosed carts or containers should be provided in these rooms and all ward procedure trays and reusable equipment placed in them. It is the user's responsibility to dispose of sharps appropriately and to remove or dispose of gross soil from items being returned to SPD.

b. Technicians are required to wear appropriate protective attire when collecting and transporting soiled items. Gloves must be changed after direct handling of contaminated items and between container drop-off sites. This procedure will help reduce the chance of cross-contamination between soiled pickup points and public conveyance (i.e., elevator buttons, door handles, telephones).

c. When transporting large equipment such as emergency carts, warming blankets, etc., a plastic bag should be placed over the item(s).

8. SOILED SUPPLY SORTING PROCEDURES

Every item that is returned to SPD Decontamination requires cleaning/decontaminating as the first step in reprocessing. Items must be sorted as they are removed from the transport container according to the process or processes to be used. Items should be inspected for condition and missing parts and origins noted so that the user can be contacted to account for condition or locate missing parts. Items are sorted into the following categories:

- a. Equipment, electrical.
- b. Equipment, nonelectrical.
- c. Rubber and/or plastic supplies.
- d. Metalware.
- e. Glassware.
- f. Surgical power equipment.
- g. Surgical instruments.
- h. Endoscopic equipment.
- i. Electronic devices.

9. CLEANING AND DISINFECTING PROCEDURES

a. The single most important procedure for good infection control and prevention of cross-contamination is the removal of all visible soil and proper application of a disinfectant. Follow specific equipment cleaning procedures provided by the manufacturer to assure the correct cleaning procedure (microbial harbors).

(1) **Equipment, Electrical.** Manually wipe down equipment starting at the top and working down. Use a brush to reach all nooks and crannies. Hand wash and inspect electrical cords, coil, and secure with a binder. Wash casters and wheels last. Apply good aseptic technique when cleaning small equipment. Be sure to wipe the work surface (counter top) with disinfectant solution before turning the item over to be cleaned. Always rinse cloth in disinfectant solution between pieces of equipment. Examples of electrical equipment are infusion pumps, feeding pumps, K-pad motors, air compressor, portable suction machines, hypothermia units.

(2) **Equipment, Nonelectrical.** Use the same procedure listed above to manually clean nonelectrical equipment. If equipment can be mechanically cleaned, it should be inspected and precleaned, removing all gross soil, tape, or residual adhesive before

cleaning in a cart washer. Examples of nonelectrical equipment are IV poles, wheelchairs, litters, K-pads, hypothermia blankets, seizure pads, foot cradles, commodes, isolation carts.



Ward Equipment

(3) **Rubber and/or Plastic Supplies.** Damage can easily occur to rubber and/or plastic supplies by using inappropriate chemicals or elevated temperatures. Manufacturers' instructions should be followed. Inspect each piece for tears, holes, or deterioration. These items can be cleaned or disinfected manually and/or mechanically. To manually wash items, use small brushes to clean inside tubes and rinse thoroughly. Items can then be dried by compressed air, tube drier, or air dried. When processing items mechanically in a washer/sterilizer, washer/sanitizer, or pasteurization machine, place items in the appropriate basket with insert before starting cycle. The baskets are needed to correctly position the items to facilitate washing and rinsing. Heavily soiled items may require precleaning prior to mechanical processing. Supplies should be thoroughly dried before any further processing takes place. Examples of rubber and/or plastic supplies include nasal airways, oral airways, reusable ventilator tubing, reusable resuscitators, pulmonary tubing.

(5) **Metalware.** Inspect each item upon receipt for gross soil and, if present, the item may need to be manually soaked and washed. Metalware can be processed through a cart washer, a washer/sterilizer, or a washer/sanitizer. It is important for the technician to use proper loading techniques. Appropriate baskets with inserts must be used to assure that the items are in the correct position during the processing cycle. In general,

metalware with open depressions should be positioned open end down to facilitate drainage. Basket inserts also keep items from excessive movement in the chamber, which can cause damage to the items, chamber, or spray arms. If an item, such as a basin or instrument container, turns right side up and fills with water, the technician should be careful when handling -- burns may occur, protective gloves may be needed. Examples of metalware are bedpans, basins, medicine cups, instrument containers.

(6) **Glassware.** Care must be taken when handling glassware. Broken glass can cause a serious wound to staff or patient. These items can be cleaned or disinfected mechanically. The technician should first inspect each item for cracks and chips. Disassemble component parts. To preclean items, use appropriate brush and detergent. Scrubbing must be done under the surface of the solution --eye protection is mandatory. **Note: Syringes should be soaked in enzyme solution first and then processed in an ultrasonic.** Items can then be processed through a washer/sterilizer or washer/sanitizer using appropriate baskets. Following the machine cycle, the items must be inspected for damage. A glass container may right itself during the cycle and fill with water. The technician must be careful when handling the container to avoid getting burned. Protective gloves may be needed. Examples of glassware are syringes, medicine cups, elik evacuator, straight and Y connectors, graduates.

(7) **Surgical Power Equipment.** Surgical power equipment must be inspected prior to processing. Although it is the user's responsibility to remove cutting blades or drill bits prior to returning equipment to SPD, sometimes this equipment is returned to the decontamination area with these items in place. This is especially hazardous if the unit is battery operated and the power source is in place. Serious injury can occur if power equipment is not handled properly. Manufacturers' recommendations should be followed regarding disassembly and cleaning. Examples of surgical power equipment are drills, saws, reamers, mini drivers.

(a) **Battery Powered Equipment.** Power source should be removed. The hand piece should be wiped down with appropriate cleaning solution, followed by wiping down with a water-dampened cloth.

(b) **Electrically Powered Equipment.** Inspect electrical cords for cracking or fraying. Wipe down with appropriate cleaning solution, follow by wiping down with a water-dampened cloth.

(c) **Compressed Air/Nitrogen Powered Equipment.** Remove the hose and inspect it for damage. Wash the hose in a mild detergent. Saline or a disinfectant solution must not be used. Wipe off the hand piece with a mild detergent, followed by wiping down with a water-dampened cloth. Care must be taken not to get the cleaning solution or water inside the hand piece. The equipment should be sent into the preparation area for further processing.

(11) Surgical instruments

a. There is a wide variety of instrumentation available ranging in complexity and quality. Instruments, as well as all patient care equipment, are a costly investment; proper handling will extend the useful life of the investment. The types of instruments that will pass through SPD's decontamination area depends on the services offered at a medical center or clinic.

b. General principals of instrument decontamination, manual and mechanical, will be examined. Instruments range in type, size, complexity, and quality. SPD technicians must be familiar with the various instrument types and their special needs.

c. The instruments used during a procedure should be rinsed in water and any gross soil removed. Instruments should be placed in covered containers or impervious bags and returned to the decontamination area using an enclosed cart.

d. Once in the decontamination area, inspect the instruments for tissue or bone remaining in the teeth or grooves. Remove this debris by holding the instrument under the surface of the solution and scrub the area with an instrument brush. Since splashing is likely, technicians must wear eye protection and mask.

e. During the initial cleaning and throughout the subsequent steps, instruments should be handled in such a manner as to avoid damage to the instrument and to prevent injury to the technician. Reprocessable sharps that have been used must not be processed in a manner that requires employees to each by hand into the containers where these sharps have been placed. Instruments should be handled in small groups to avoid tangling and damage. Needles should be separated and processed separately. The technician should watch for scalpel blades still attached to knife handles -- these should be removed and disposed of in sharps containers. All scalpel blades, disposable needles, saw blades, and drill points used during a surgical procedure should be disposed of by the operating room staff, but may be inadvertently overlooked. Many instruments contain sharp edges and parts, and extreme care should be taken by the technician while handling any sharp item.

f. During the cleaning process, always remember to open all instruments. For example, scissors should be opened, instruments with box locks should not be in a locked position, and multipiece retractors, staplers, etc., should be disassembled prior to cleaning. This allows for all areas to be exposed to the cleaning process.

Attention to all cannulated items or items with lumens, such as suction tubes, needles, and some orthopedic instruments is vital. These areas may harbor blood and body tissue. Brushes are available from manufacturers in many sizes allowing access to the cannulated areas and should be used faithfully to assure any and all debris is removed.



Cleaning Process

g. Only nonabrasive cleansers should be used for instrument cleaning, as the abrasive cleaners can damage the surface of the instrument, resulting in corrosion and rust. Instruments should be exposed to detergents that maintain a pH between 6.0 and 8.0. A neutral pH of 7.0 is ideal since a pH level too high (alkaline) or too low (acidic) will damage the surface of the instrument. Once this process is complete, rinse the instruments and process in the ultrasonic.

h. The **ultrasonic** will penetrate into the box locks, joints, and screw areas of the instrumentation. The cleaning solution used in the ultrasonic should be changed frequently. Instruments should be placed loosely in the ultrasonic in metal baskets. Never use plastic or rubber in the ultrasonic because they will absorb the sound waves and the process of cavitation will not take place. Instruments should then be rinsed and processed through the washer/sterilizer. Items that cannot be processed through the washer/sterilizer should be rinsed and placed in the drying chamber of the ultrasonic. If a drying chamber is not included on existing equipment, the instruments should be air dried or patted dry with an absorbent material so that no water is left standing on the instruments.

i. **Washer/sterilizers** are the next step in the cleaning process. Stainless steel instruments should not be processed close to instruments made of metals, such as nonanodized aluminums, brass, copper, or chrome plating. A reaction known as electrolysis may occur, resulting in one metal plating onto another. This reaction can

result in permanent damage and staining. Ideally, demineralized or deionized water should be used in the washer/sterilizer to prevent mineral buildup and chemical reactions associated with regular tap water. A drying cycle should be set to assure the instruments will dry completely and not emerge into the prep room wet after the cycle.

j. **Microsurgical and delicate eye instruments** should not be processed through a washer/sterilizer because the turbulent action of steam mixed with water may damage them. Once these delicate instruments are processed through the ultrasonic, rinsed, and dried, they should be processed on a sterilize cycle only to assure a decreased bioburden is achieved to allow safe assembly by the preparation room instrument technician.

k. **Endoscopic Equipment.** There are two types of endoscopic equipment, rigid and flexible. The use of this type of equipment has increased and their use is expected to expand. The popularity of endoscopes is due to the fact that they cause far less trauma to the patient. However, the equipment is very delicate and extremely expensive, and special attention must be given to the decontamination process. Discussed are general principles of processing scopes and should not be applied to specific equipment. Before processing a scope manually or with the use of a scope washer, consult the manufacturer's instructions.

l. **Rigid endoscopes** are used primarily in the operating room but are also used in a clinical setting. Following use, the user wipes down the scope and places it in a covered container. The container is then transported to SPD's decontamination area. To manually process a rigid endoscope, first check the scope for damage, such as clouded lenses, bent instrument shaft, and burrs on the tip of the instrument shaft. Remove the fiber optic light cable from the scope. Wipe down scope, light cables, and adapters using appropriate cleaning solution. Thoroughly rinse items by wiping down with a water-dampened cloth. Careful attention should be paid to the lenses -- they should be wiped with an alcohol-dampened swab/applicator. The scope should then be dried thoroughly. Before processing any scope, the technician should consult all manufacturer's instructions. Examples of rigid scopes include arthroscopes, cystoscopes, bronchoscopes, laryngoscopes.

m. **Flexible endoscopes** can be used by a variety of services within the medical center, such as GI, Procto Clinic, Respiratory, Surgery, and ENT Clinic. Scopes should be wiped down and flushed with a cleaning solution immediately after use. The scope should then be placed in a covered container and transported to the SPD decontamination area. Since several different services use endoscopes, it is advisable to keep a check sheet in the decontamination area and record the location, serial number of each scope, date, and time in and out. Before processing any scope, the technician should consult all manufacturers' instructions. Flexible scopes can be cleaned and disinfected manually or through a scope washer.

n. **Manual processing** of flexible endoscopes requires the following equipment: leakage tester, large basin of appropriate cleaning solution, appropriate cleaning supplies, and brushes. To manually clean scopes, remove caps and/or valves on scope. Using an enzyme solution, brush the channel(s) and flush until completely clean. Hook up scope to leak tester to check integrity of the channel(s). This should be followed by inspection of the outer casing of the scope. If no damage is detected, the scope is ready to be processed in a cleaning or disinfecting solution, followed by rinsing and drying. Scopes that are terminally sterilized in EtO do not need to be processed in a disinfecting solution, such as glutaraldehyde.

o. **Automated cleaning/disinfecting** of flexible endoscopes requires the technician to have a thorough knowledge of how the scope washer operates. Before placing the scope in the scope washer, follow the steps outlined for manual cleaning. Once the manual cleaning is complete, the scope is ready to be processed in the scope washer. Follow the manufacturer's instructions for specific scopes and scope washers. Each different type of scope has a specific adapter. Selection of the correct adapter is critical. The adapters are fastened to the open channels of the scope so that there is access to the cleaning and disinfecting solution. After disinfecting, the scope is passed through to the preparation area for further processing. Examples of flexible endoscopes are sigmoidoscopes, colonoscopes, bronchoscopes, intubation scopes, cystoscopes.

p. **Electronic Devices.** A variety of electrical cords, cables, and leads come to the decontamination area for processing. These items are delicate and should be handled carefully. The manufacturer's instructions should be thoroughly reviewed before processing this type item. General cleaning procedures are as follows: Inspect the outer case of the device for cracks, tears, or deterioration. Prepare a detergent solution, dampen cloth and wipe down casing. Do not immerse the device in the detergent solution or use disinfectant unless the manufacturer's instructions indicate to do so. Following cleaning, the device should be wiped off with a water-dampened cloth. The device should air dry and then be sent to the preparation room. Examples of electronic devices are bovie's, pacemaker cords, defibrillator paddles, EMG needles, EKG leads, rectal probes.

10. INFECTION CONTROL PRACTICES

a. **Universal Precautions** should be strictly followed in the decontamination area. It is the technician's responsibility to be familiar with these policies and procedures for their own protection. Important factors to remember are hand washing, sharps safety, spills, soiled laundry, infectious waste, and environmental cleaning.

b. **Hand Washing.** Hand washing is the single most important step in preventing cross-transmission of infectious agents; it allows protection of the patient and the SPD technician. Hand washing is indicated in the following situations:

- (1) Immediately after unanticipated contact with blood or body fluids.
- (2) Immediately after gloves are removed.
- (3) For personal hygiene, i.e., arrival at the work site, use of the lavatory, before and after eating, and before returning to the job site.

c. **Sharps Safety.** Sharps are defined as: needles, scalpel blades, and other sharp objects that can penetrate the skin. Safe use must include:

- (1) Technicians must inspect procedure trays carefully for sharps that have not been disposed of at point of use.
- (2) Disposal in a puncture-resistant container immediately.
- (3) Always use a forceps to remove a scalpel blade from a reusable handle.
- (4) Never attempt to pick up broken glassware with your hands. Check procedures for proper disposal in your facility.
- (5) Never put your hands in a sharps container to retrieve items that were accidentally disposed.
- (6) Sharps must never be placed in uniform pockets or used for box openers, removing tape, etc.

d. **Spills.** After a disinfectant is used to clean where infectious material has been spilled or sprayed, the affected area must be allowed to air dry. In the case where a large volume of potentially hazardous material has been spilled, your supervisor and Environmental Management Service should be contacted and appropriate steps taken to reduce further contact to co-workers (wet floor signs, etc.).

e. **Soiled Laundry.** Soiled laundry, such as towels, reusable drapes, cleaning rags, etc., shall be handled as little as possible to prevent further contamination or exposure. It shall be placed in the appropriate moisture resistant laundry bag. SPD technicians, who come in contact with contaminated laundry, should wear appropriate personal protective clothing.

f. **Infectious Waste.** All body fluids and disposable items visibly contaminated with body fluids should be discarded as infectious waste. Infectious waste is any substance deemed to be potentially harmful to personnel or the environment by way of cross-contamination. Impervious containers with a secure fitting lid should be provided in the decontamination area. The container should be emptied and disinfected regularly by Environmental Management Service.

g. **Environmental Cleaning.** Environmental Management Service is responsible for cleaning the floors and walls of the decontamination area. SPD technicians are responsible for cleaning all work surfaces and sinks at the end of each shift and as needed.

11. SAFETY

a. As with Universal Precautions, the SPD Policy and Procedures Manual covers safety related guidelines for technicians to follow. It is the technician's responsibility to know and observe safety rules.

b. **Material Safety Data Sheets (MSDS).** These are documents prepared by the manufacturers of chemical products and provided to the user so they understand the safe use of the products. SPD must have a copy of the MSDS for each chemical that is used. These copies must be assembled in the Policy and Procedures Manual and referenced where they are located. The MSDS usually consist of 8 to 10 sections of information regarding health hazards, emergency procedures, precautionary measures, and first aid techniques. SPD technicians must review the MSDS before handling any potentially hazardous chemicals.

c. **Eye Wash Stations.** These are used for emergency eye flush in the case of a chemical splash in the eye. Technicians must be knowledgeable in how and when to use this equipment.

d. **Physical Hazards.** SPD staff should follow all safety procedures in the performance of their job duties. Proper body mechanics should be used when lifting or bending is required. Any injuries, unsafe conditions, or practices should be reported immediately to supervisory personnel. Some of the areas of potential safety hazards in the decontamination area are:

- (1) Open drawers.
- (2) Sharps and needle sticks.
- (3) Carelessly stacked washer/sterilizer baskets.
- (4) Automatic cart washer doors.
- (5) Lifting heavy objects.
- (6) Slippery wet floors.
- (7) Automatic loaders/unloaders and doors of washer sterilizers.
- (8) Hot items.
- (9) Improper use of chemicals.
- (10) Operating equipment noise.

DECONTAMINATION TERMS

Atmosphere Pressure
Bioburden
Box Lock
Cannulated
Cart Lift
Cart Washer
Cross-Contamination
Decontamination
Deionize
Detergent
Distilled
Dumbwaiter
Electrolytic Deposition
Endoscopes
Hemostat
Infectious Waste
Instrumentation
Manual
MSDS (Material Safety Data Sheet)
Microsurgery
Negative Pressure
Pitting
PPE
Pasteurmatic
Processing
Scopewasher
Serrations
Sharps
Steam Gun
Tube Drier
Utensil Washer
Universal Precautions
Washer/Sterilizer
Washer/Sanitizer

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DECONTAMINATION

1. Personal protective equipment for the decontamination area consists of _____, _____, _____, _____, _____, _____, _____, and _____.
2. Detergents are used to aid in the removal of _____ from the surface of the surgical instrument or a piece of equipment.
3. A chemical disinfectant is a substance that is used to kill _____.
4. Manufacturers of chemical products are responsible to provide _____ _____ _____ to facilities that purchase their product.
5. Proper _____ should be used when _____ or _____ is required.
6. The decontamination of SPD is a physically _____ area specifically designed to meet the medical center's needs.
7. The decontamination area should be under _____ air pressure.
8. _____ _____ should originate from outside of the decontamination unit and travel inside through a dedicated entry way.
9. Negative air pressure is essential to reduce _____ into surrounding areas.
10. Work surfaces should be cleaned _____ with a low level disinfectant.
11. All equipment and supplies returned from patient care areas are considered _____.
12. The appropriate _____ _____ _____ should be worn when transporting contaminated equipment.
13. Ideally all nursing units and clinic areas should have a _____ utility room.
14. When transporting large equipment, a _____ should be used to cover it.
15. Immediately after all supplies have been delivered to decontamination, _____ should be removed.
16. Cleaning is preliminary to _____ and _____.
17. The removal of _____ is most important to the sterilization process.

18. Once disinfected, items must not be allowed to become _____ before sterilization.
19. Most washing detergents contain _____ agents that cause foam.
20. When cleaning equipment follow specific _____ to assure correct cleaning.
21. Apply good _____ technique when cleaning all equipment surfaces.
22. All cannulated items must be soaked and flushed followed by cleaning the _____ with a brush.
23. Types of mechanical processing equipment that would be found in a decontamination area are _____, _____, _____, _____, _____, _____, _____, and _____.
24. An _____ cart should be used when making soiled instrument pickups.
25. Soiled supplies can be returned on dedicated _____ or _____.

TRUE OR FALSE

26. Shoe covers that are worn in the decontamination area do not have to be water resistant.
27. A tube dryer is capable of killing pathogenic microorganisms.
28. A cart washer is used to clean and sanitize carts, wheelchairs, and litters.
29. The Center for Disease Control published guidelines for Universal Body Substance Precautions to help medical centers develop local plans to protect healthcare workers.
30. Eye protection is an option, not a requirement when processing instruments and supplies when splashing is likely.
31. Employees should wash their hands when leaving the decontamination area and before returning.
32. Disposable sharps, such as needles and scalpel blades, should be carefully disposed of in a puncture resistant container.
33. The decontamination area of SPD should be under positive air pressure.

34. Decontamination process begins with the removal of gross contamination.
35. It is important to wear eye protection when splashing may occur.
36. Wearing gloves is only necessary when transporting visibly soiled equipment.
37. Gloves should only be changed when torn or punctured.
38. Plastic bags are the only way to transport soiled supplies.
39. Tote bins provide excellent barriers to cross-contamination.
40. It is acceptable to use equipment between patients if no visible soiling is present.
41. Always rinse cloth in disinfectant solution between pieces of equipment.
42. Universal Precautions guidelines were developed to help medical centers develop local plans to protect healthcare workers.
43. The purpose of the decontamination unit is to clean and sterilize medical instrumentation and equipment.
44. Types of eye protection include face shield and goggles.
45. Wearing gloves is only necessary when transporting visibly soiled equipment.
46. Surgical gloves can be work in the decontamination area.
47. A detergent should have a pH between 2.0 and 5.0.
48. The SPD Section must have a copy of the MSDS for each chemical that is used in the section.
49. An ultrasonic cleaner is used to clean and disinfect surgical instrumentation.
50. Only nonabrasive cleaners should be used for instrument cleaning as the abrasive cleaners can damage the surface of the instrument, resulting in corrosion and rust.

MATCHING

51. _____ Decontaminating equipment that uses sound waves to remove minute particles of soil from instrumentation. A. ultrasonic cleaner
52. _____ Items such as bed pans, emesis basins, and instrument trays must be properly positioned in the chamber of a washer/sterilizer, washer/sanitizer, or utensil washer. B. hand washing
53. _____ Soiled equipment can be automatically transported to the decontamination area. C. basket & insert
54. _____ Single most important step in preventing cross-transmission of infectious agents. D. disinfectants
55. _____ Disposable needles, scalpel blades, and chipped glass syringes should be disposed of. E. lifts/dumwaiter

MULTIPLE CHOICE

56. Equipment capable of killing microorganisms, including bacterial spores:
- a. washer/sterilizer
 - b. ultrasonic cleaner
 - c. medium-level disinfectant
 - d. none of the above
57. An example of personal protective equipment:
- a. impervious gown
 - b. water resistant shoe covers
 - c. surgeon's gloves
 - d. a. and b.

58. Rubber and/or plastic items should never be processed through the following piece of equipment:

- a. scope washer
- b. washer/sterilizer
- c. washer/sanitizer
- d. ultrasonic cleaner
- e. a. and b.

59. The following equipment should be hand cleaned and not sent through the various mechanical processing units:

- a. electronic cords
- b. EKG leads
- c. infusion pump
- d. feeding pump
- e. all of the above

60. Detergent solution must be used with the following equipment:

- a. tube dryer
- b. pasteurmatic washer
- c. utensil washer
- d. b. and c.

PACKAGING

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Packaging



WRAPPING

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OBJECTIVES

Following training, employees will be able to:

1. Understand and explain the principles of packaging.
2. Know the ideal packaging materials and how they affect sterility.
3. List the types of packaging materials available for use in the hospital setting.
4. List the importance and guidelines for linen pack construction.
5. Explain how linen packs should be assembled and the proper placement of gowns, drapes, etc., within the pack.
6. Describe the proper assembly of procedure trays, basin sets, and basin packs.
7. Demonstrate the appropriate wrapping techniques as required for various packs, sets, and instrument trays.
8. Explain shelf life and what affects the sterility of items.
9. Explain the length of time various packaging material can be expected to remain on the shelf before reprocessing.
10. Explain the importance of proper handling and storage to assure sterility.

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PACKAGING

1. PRINCIPLES OF PACKAGING

a. Special care should be taken to assure an item is thoroughly cleaned, decontaminated, assembled, and sterilized correctly. All the effort involved to ensure a sterile product can be lost by incorrect packaging and handling. Many conditions must be met in SPD to achieve the desired goal and primary objective of patient safety.

b. Four basic principles must be achieved to maintain the standards of packaging: it must allow adequate penetration of the sterilant, provide a barrier to microorganisms, and allow sterile presentation of the package contents. The fourth and probably most important principle to remember is: sterility is event-related and not time-related. No matter how adequate the packaging, proper handling and storage are vital to provide a sterile product.

c. The ideal packaging material should:

- (1) Allow adequate penetration of the sterilant.
- (2) Not be a barrier to the exhaust of steam from the package or entrap ethylene oxide. (Allow for adequate air removal)
- (3) Maintain a barrier to microorganisms.
- (4) Withstand the extreme pressure during the sterilization cycle.
- (5) Tolerate handling and resist tears and puncture.
- (6) Be easy to use and conform to all wrap procedures. Easy to seal, yet tamper resistant.
- (7) If holes or tearing occur, these holes should be visible to the naked eye.
- (8) Have tamper proof heat seals on pouches and should retain seals during the sterilization process.
- (9) Allow for aseptic delivery.
- (10) Be inexpensive and readily available.

(11) Be moisture resistant.

(12) Allow for protection of the package contents.

(13) Have visible identity of the package contents.

d. Some of these characteristics may be more important than others, depending on the items to be packaged and how they will eventually be used. Packaging materials must be able to withstand the sterilization process. Vacuum and pressures created during sterilization are extreme; packages should not burst or deteriorate during the process. Changes in temperature can cause melting, burning, or otherwise alter the materials.

e. Adequate air removal is required during sterilization to assure that all surfaces of the contents have been exposed to the sterilant, regardless of the type of sterilant -- steam or ethylene oxide. The packaging material must also allow for rapid air and gas removal at the end of the cycle to assure removal of the ethylene oxide and to allow removal of moisture from the steam sterilization cycle. Some packaging is not suitable for use in the steam sterilizer, such as plastic film, since it does not allow penetration of the steam. Ethylene oxide, on the other hand, cannot penetrate packaging that consists of nylon or aluminum foil.

f. After sterilization is achieved, the packaging must maintain a barrier against dust and the microorganisms that use dust as a vehicle to move from place to place. A barrier to dust can be created by providing a "tortuous path." The tortuous path forces dust particles to turn at right angles many times before reaching the package contents, thus creating a barrier to the microorganism.

g. Packaging materials must not allow moisture to "wick" along fibers and move through the spaces between fibers. This is accomplished by retarding wicking action or by being impermeable to water.

h. Materials must allow proper sealing so that the contents will remain within the package and the package will remain closed. Materials should also be tamper proof to prevent opening and resealing; and adapt to the size, shape, and nature of the item being packaged. Too much material may inhibit sterilant penetration, while too little will not provide adequate protection.

i. Packaging materials should be durable and resist tearing, punctures, and withstand normal handling. They should also provide protection to the items contained within. If the items to be sterilized are fragile, rigid plastic and metal containers should be used. Tip guards and foam inserts can provide protection to fragile and sharp items.

j. Aseptic presentation of the sterile contents of any type of packaging is of utmost importance. After taking steps to assure sterility, if the item cannot be presented in a manner to maintain its sterility, all efforts have been in vain. This is one of the most important reasons for selecting the proper packaging material.

2. TYPES OF PACKAGING MATERIALS

a. Textiles

(1) Textiles consist of two layers of fabric sewn together along the edges to create one wrapper. Extensive data has been compiled of all the available packaging, and muslin, even at its best, is the least efficient. This textile product consists of 140 thread count or less. Percale consists of 140 to 180 thread count. (Thread count consists of the number of fabric threads per inch.) Pima cotton has 288 thread count and is treated with quarpel to make it moisture resistant. It is an excellent bacterial barrier, but very expensive.

(2) Woven textiles require laundering, inspection, delinting, and folding between uses. They should only be laundered 50 to 60 times, then replaced. Many facilities do not track the number of washings, resulting in a wrap that has lost most of its barrier capability. Repairs should also be made if holes are found. Holes can be detected with the use of a light table. Light tables are not always utilized as they should be, allowing for use of wraps that do not maintain a barrier. Once tears or holes are discovered, the area will require a patch. A patch must be placed on both sides of the wrap. Patches do not allow penetration of the sterilant. Woven wraps are cheaper, but the laundering costs and man-hours required to maintain them, in the long run, end up costing more than the disposable wraps.

b. Nonwoven Materials

(1) Nonwoven materials are intended for single use and are to be disposed of after use. Many varieties and thickness of disposable wraps are available today. Heavy wraps are designed to wrap heavy objects and large instrument sets. Lighter wraps are available for light weight items. The choices are numerous. Nonwoven packaging materials consist of plastic polymers, cellulose fibers, or washed paper pulp bonded under pressure into sheets. Plastic polymers are impervious to moisture, whereas materials made of untreated, washed paper pulp can become wet, causing strike through.

(2) Recent concerns over excessive disposables in land fills have emerged. To prevent this, several companies, producing nonwovens, have created recycling programs. A carefully planned, safe recycling program for disposable wraps should be thoroughly reviewed to prevent any possibility of cross-contamination. Some programs across the country have been successful with this.

c. Films

(1) Some plastic polymers can be extruded into sheets of varying thicknesses. The thinner sheets may contain small pinholes, so it is recommended that film for packaging applications be at least 2 mils thick. A mil equals 1/1000th of an inch. Water, in the vapor or liquid phase, cannot penetrate plastic films and should not be used for steam sterilization, unless it is used in conjunction with paper. Films may be used for ethylene oxide sterilization; however, film constructed of polyvinyl chloride (PVC) is not recommended since it is poorly penetrated by ethylene oxide and it is difficult to remove ethylene oxide that remains in the packaging and the film itself.

(2) Plastic films are used after sterilization as a dust cover for woven and nonwoven wrapped sterile items. This dust cover will protect the item from moisture and dust, and will extend the shelf life to 1 year. The sterilized item must be completely cool before placing in the dust cover to prevent condensation inside the cover.

d. Containerized Packaging Systems

(1) After reusable sterilization containers had been used successfully in European hospitals for several decades, the concept was finally introduced in North America in 1979. This innovation resulted from a need for greater sterility assurance against the common problems of lint, tears, punctures, patches, and moisture strike-through. Greater protection for expensive surgical instrumentation became apparent as instruments became more complex and more expensive.

(2) These systems consist of a metal or plastic outer case, an inner basket constructed of stainless steel, and a gasket along the lid to assure an airtight seal once the lid is locked into place. In the lid, and sometimes the bottom of the case, an area of perforations is covered with a filter paper, then a screen or retainer frame to hold the filter paper in place over the perforations. The filter paper consists of nonwoven material. Inspection of the gasket and retainer frames should be done each time the container is assembled. One type of system utilizes a valve instead of a filter paper and retaining frame. The valve must be checked for proper functioning to assure the sterilization process will not be inhibited.

(3) The tops can be removed aseptically to allow for easy access of the inner basket. After surgery, the soiled items can be placed back into the system to assure safe transportation to the decontamination area.

(4) The containers save time during assembly, versus using the woven or nonwoven wrap. Tamper proof indicators are utilized with all types of containers. This allows a quick visual check to assure the container has not been opened. Labels are located on the end of the containers denoting the name of the set and allows for the placement of

the sterilization date. Sterilization indicators can be part of the tamper proof item or may be included on the tag used for the sterilization date and technician's initials.

e. Packaging Methods

(1) Methods of packaging depend solely on the type of items to be packaged for sterilization. Instrument sets used by the operating room may be packaged in metal perforated bottom instrument trays that are wrapped with muslin or nonwoven wrap or can be placed into containerized systems. Containerized systems provide more protection than other types of packaging. Containers should be used in prevacuum steam sterilizers, versus gravity displacement sterilizers, since air removal is difficult without the vacuum phase.

(2) Metal containers cannot absorb water like fabric wrappers, so the sterilizer drying times may need to be increased. With so much metal being subjected to heat, moisture will tend to evaporate easier than it does from woven textiles. Containers should be placed on the sterilization rack to allow movement of air and to prevent condensation forming and dripping onto the lower shelf. If a mixed load is necessary, the containers should be placed on the bottom shelf, and all other packages on the top shelf. It is not advisable to mix any load containing fabric packs and metal instruments. Containers should not be stacked on one another during the sterilization process, but may be handled as soon as they cool enough to be handled without burns, and may be stacked for storage without danger of contamination due to puncture or tearing.

f. Linen Pack Construction

(1) Packs come in a variety of sizes and are mainly used in the operating room. Towels and other small packs may be used in clinic or special procedure areas. The density of fabric packs should not exceed 7.2 pounds per cubic foot. The size should not exceed 12 x 12 x 20 inches. Special care must be taken when folding packs containing woven materials to ensure aseptic presentation and to minimize handling at the point of use. Linen packs are to be arranged in the order in which the items will be used. The layers of linen should be alternated so the folds do not all go in the same direction. This will aid in the air evacuation and steam penetration.

(2) The gowns contained in the linen pack should be folded inside out, allowing the scrub nurse the ability to don the gown without touching the outside, which will maintain the sterility of the gown. Drape sheets are folded so that minimal handling will be necessary to open and place them around the operative site on the patient.

(3) The laundry department of most Veteran Administration Hospitals is required to handle all surgical linen. This includes maintenance and care, and folding and assembly of the surgical linen packs. Folding and delinting should not be carried out in the SPD preparation room. If SPD must fold and delint linen, a separate room, with a light table and linen storage area, must be provided away from the preparation room.

(4) Construction of instrument sets was discussed in the Instrumentation Chapter. In general, instruments should be placed in a tray to allow adequate exposure to the sterilant and provide for safe handling. Instrument sets may be muslin or nonwoven wrapped or a containerized system used.

(5) Procedure trays will be assembled using towels, some instruments, small basins, med cups, and gauze. They will be wrapped in muslin or nonwoven material and usually placed on their side during the sterilization process. Slow moving procedure trays will require the use of dust covers.

(6) Basin sets should be constructed so the smaller basins nest inside the larger basin. Basins should face in the same direction, and a material, such as an absorbent towel, should be placed between them to facilitate steam penetration and allow for moisture to be wicked away from the metal. Basins that face in different directions or fit tightly together can trap air and prevent steam contact to all surfaces. Metalware and linen should not be combined in large packs, since the metal may prevent steam penetration of all the linen and prevent proper drying.



Procedure Tray



Basin Pack

g. Wrapping Techniques

(1) Once an item, pack, or instrument set is prepared, the proper size wrap, whether woven or nonwoven, must be selected. It is very important to choose the size that will be large enough to completely enclose the items being packaged and to allow all edges and corners to be tucked securely. Wrappers too large may impede the penetration of the sterilant and not hold together securely. Wrappers should be just tight enough to hold the contents together and allow easy penetration of the sterilant.

(2) The outside wrappers provide a barrier to contamination during handling and against insects or vermin and serve as a dust barrier. The inside wrap, when opened, may be used as a sterile field, if so desired.

(3) Proper folding of the wrapper is necessary to secure the package contents and to allow the package to be opened correctly without contaminating its contents. There are two most common techniques used for wrapping packs and other medical items. These two techniques are: the square fold (straight method) and the envelope fold (diagonal method).

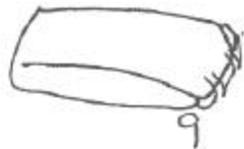
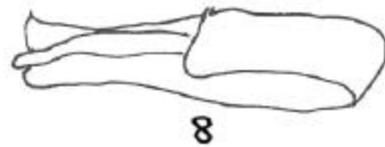
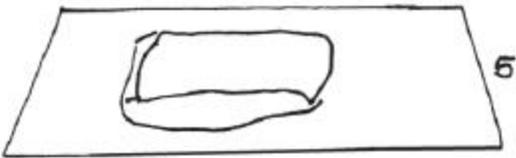
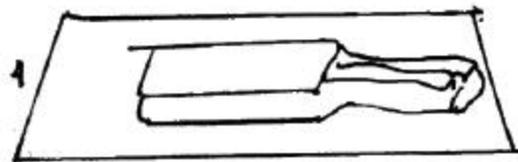
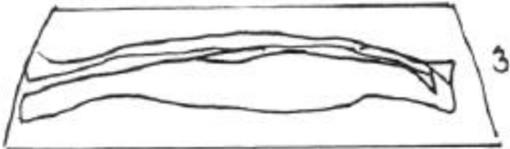
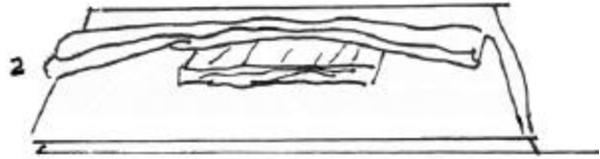
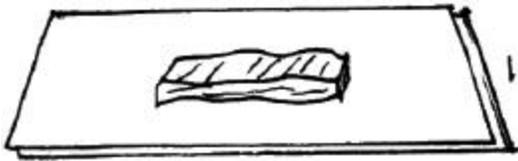
Square Fold

1. Place the wrappers lengthwise across the table. The item to be wrapped should be placed in the center of the wrapper.
2. Fold the edge of the wrapper at the front of the table over the top of the item so as to cover the lower half of the item. Then fold it back to form a cuff.
3. The other (opposite) edge of the wrapper is folded over the upper half, then folded back to form a cuff over the previous cuff.
4. Fold the left edge of the wrapper snugly over the item and fold back slightly to form a cuff.
5. Repeat with the right side, overlapping the previous fold.
- 6-9. Repeat the procedure for the second wrapper, except bring the last fold over the end of the package and secure with sterilization indicator tape.

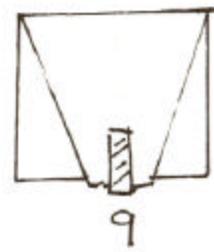
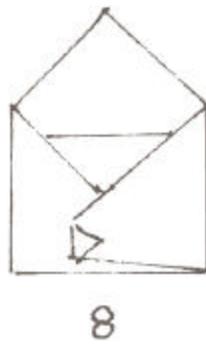
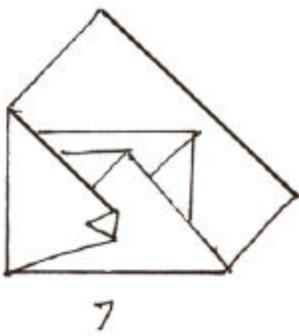
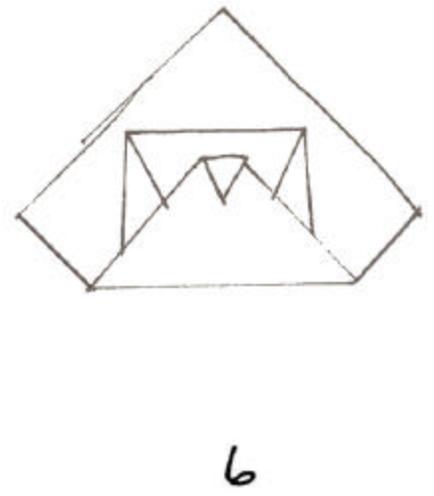
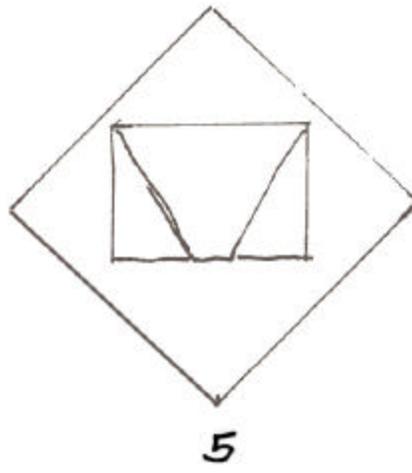
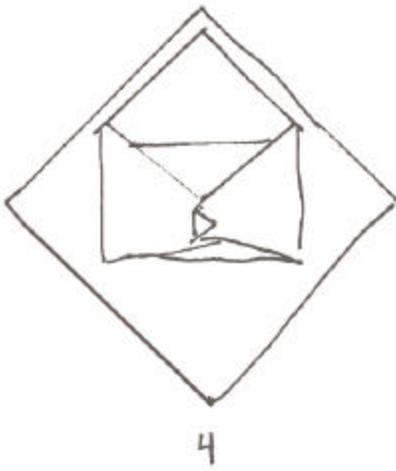
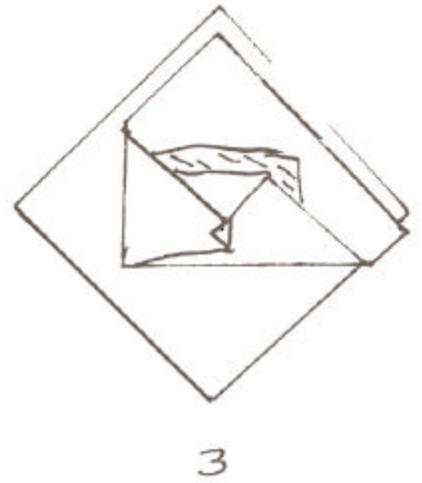
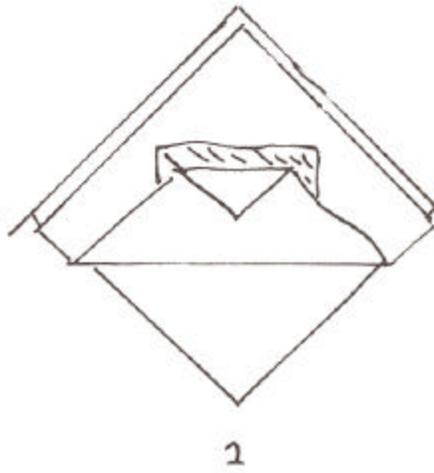
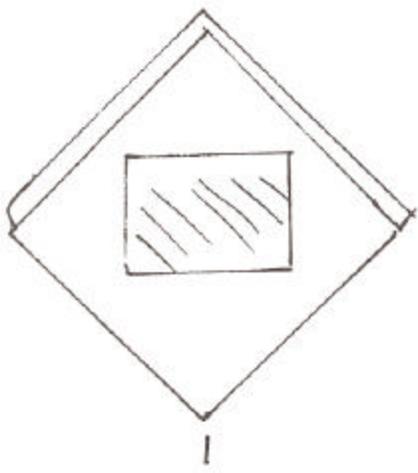
Envelope Fold

1. Place the square wrappers on the table in a diagonal position, with the one corner pointing toward the front of the table. Place the item to be wrapped in the center of the wrapper at right angles to the top and bottom corners.
2. Fold the bottom corner over the item and fold back to form a tab, which will be used to open the package.
3. Fold the left corner over the item and fold back to form a flap.
4. The right corner is then folded over the item, overlapping the previous fold, and then folded back to form a flap.
5. Fold the top corner of the wrapper over the item and previous fold and tuck the flap under the previous left and right folds, leaving a small tab visible for easy opening.
- 6-9. The second wrapper is applied in the same manner, except the last fold is not tucked under the previous folds, but rather is carried around the edge and then secured with sterilization indicator tape.

Remember, the wraps should be sequentially wrapped, meaning one at a time. After the wrapping is complete, the closure must be properly secured. Sterilization indicator tape (autoclave tape) should be used. It secures the wrapper while providing an external visual indication, once processed, that the package has been subjected to



SQUARE FOLD OR STRAIGHT METHOD OF WRAPPING



ENVELOPE FOLD OR DIAGONAL METHOD OF WRAPPING

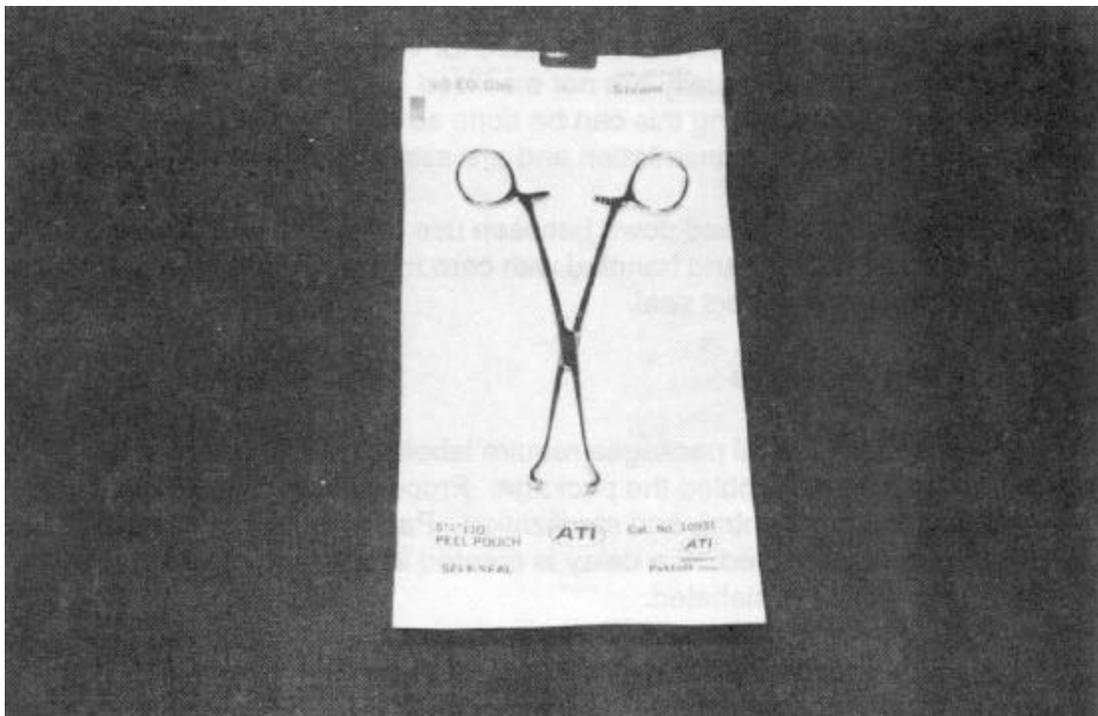
sterilization conditions. The technician will use the tape as a place to label the package and to initial. Packages should never be secured by paper clips, pins, staples, or other sharp objects that could penetrate the surface of the wrapper. Packs should never be secured with string.

g. Pouches

(1) Pouches are used when the visibility of an item is important, and are used for items too small to wrap. The pouch should fit the size of the object to be placed inside. It should neither be too small, causing the pouch to bulge and burst at the seams, nor too large, allowing the item to move around inside.

(2) Pouches can be preformed, with all sides sealed except one, or may come in rolls, allowing the technician to cut the desired length required. The roll type requires two seals. One at the top, with at least a one-inch section left beyond the seal to allow for proper peel down, and a seal at the very bottom. The seals should be at least 3/8 inches wide to provide for proper closure. Anything smaller than this will require two seals.

(3) Pouches are made from a variety of materials, including paper, polyethylene, cellophane, and spun-bonded olefin, and various paper/plastic combinations. The most commonly used are the paper/plastic preformed pouches.



Item placed in pouch

(4) The end or handle of the instrument, that will be grasped first, should be placed in the pouch in such a manner as to allow the user to grasp the item without contaminating it when the pouch is opened. All items packaged in pouches for use in the operating room should be double packaged, as mentioned in the Instrumentation Chapter. This allows for access to the sterile inside pouch by the operating room scrub nurse.

(5) Heat sealing is the most widely used method for sealing pouches. Special heat sealing machines, in several makes and models, are available for this purpose. Always obtain the manufacturer's instructions before operating any type of equipment. The technician using the sealers should be aware of the heat produced, and use care and good judgment to prevent burns. The heat sealing process bonds the plastic to the paper. Once the seal is made, it should be inspected to ensure it is complete and secure.

(6) Some pouches are "self-sealing." A sticky strip at the end of the pouch is removed, and the end is folded over the opening. Care must be taken to seal the pouch correctly to prevent gaps or wrinkles, which will allow microorganisms to enter. Pouches will not be secured by any other means, such as paper clips, pins, staples, or any other method which will damage the package integrity.

h. Containerized Systems

(1) Containers are mainly used for surgical instrument sets and some powered equipment. Containers sometimes are used for very small sets, and they come in a variety of sizes. Linens usually are not sterilized in these systems, and no studies have been completed stating this can be done safely. Containers provide added protection to surgical instrumentation and are assembled easily and quickly.

(2) They should be wiped down between use (or processed through a washer/decontaminator) and handled with care to prevent damage to the edges, which may prevent a perfect seal.

i. Labeling Packages

(1) The contents of all packages require labels to identify what is inside the package, and who assembled the package. Proper labeling is necessary for quality assurance, inventory control, and sterilization. Packages should be labeled as soon as the package is wrapped. If a delay is created in labeling, chances increase that the packages will be mislabeled.

(2) For tape-secured packages that are hand-labeled, felt-tip, indelible ink markers will be used to record all the necessary information on the tape. Never write on any wrapper material -- the tape must be used for this purpose. Indelible ink is necessary so the marking will not run or fade, or redeposit onto the surface of the instruments.

Preprinted indicator tape can be purchased for high volume items.

(3) The label information should include:

(a) Description of package contents.

(b) Expiration date and color coded marking to track time on the shelf.

(c) SPD technicians' initials.

(d) Sterilizer label, to include sterilizer number, cycle sequence, expiration date, and date of sterilization.

(e) Service name should the item be marked for return.

(4) Package contents and technician's initials prior to sterilization. The sterilizer expiration date and label will be placed on the package after sterilization.

j. Shelf Life

(1) Shelf life literally means the time expected for an item to remain sterile on the shelf. Many things can affect the shelf life, such as storage conditions, climate and humidity controls, traffic, and access to the area.

(2) An SPD processed and packaged item remaining on the shelf unused for 6 months must be evaluated for need and inventory level adjustment. It must be determined at the 6-month evaluation whether to relocate the item to a higher use area or maintain it in its present location. Color codes will be assigned to each package at the time of labeling and packaging. The color codes will designate the month of expiration, and can be used to prompt an inventory evaluation at the end of 6 months. Color codes, designating specific months, will be assigned as follows:

If the month is: apply the appropriate color for a 12-month outdate:

- | | |
|-------------|--------|
| 1. January | White |
| 2. February | Purple |
| 3. March | Green |
| 4. April | Yellow |
| 5. May | Blue |
| 6. June | Gray |
| 7. July | Black |

8. August	Brown
9. September	Pink
10. October	Orange
11. November	Gold
12. December	Red

(3) Items should not remain on the shelf if not used after a year. Evaluations must be made to determine the necessity of maintaining the item.

Guidelines for shelf life for the following items are:

Woven and nonwoven wrapped items with no dust cover	30 days
Woven and nonwoven wrapped items with a dust cover	1 year
Paper/plastic peel pouch	1 year
Containerized systems	1 year

(4) Commercially sterilized items usually carry an indefinite shelf life. It is indicated on the label that the contents are sterile unless the package integrity has been compromised.

(5) The expiration date does not indicate whether an item is sterile. Contamination doesn't suddenly occur on the last day of the labeled shelf life. Sterility is "event" related, not time-related. Many things can be involved in the life of a sterile item, such as improper handling, not allowing adequate cooling time after sterilization, excessive stacking of items, exposure to extreme climate conditions, the type of bacterial barrier provided by the package material, and how well the package is sealed.

(6) The expiration date does not indicate whether an item is sterile. Package integrity should be checked prior to use.

(7) Many types of materials and systems are available today for use in packaging items for sterilization, including methods of preparing packages and the importance of proper labeling. The newest item on the market is the single nonwoven wrap, which, in itself, will provide a strong barrier without the need of a sequential wrap. Further investigation and documentation are required before hospitals can accept this type of wrapper.

PACKAGING TERMS

Air Removal
Barrier
Container
Envelope Fold
Films
Muslin
Nonwoven
Peel Pack
Plastic Polymer
Pouch
PVC
Shelf Life
Square Fold
Textile

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PACKAGING

TRUE OR FALSE

1. Any material can be used to wrap a tray or set, as long as it can be taped shut, and opened without contaminating the item.
2. Containerized systems do not need to be entirely cool to move them, since strike through cannot occur with this type of packaging.
3. Proper handling is not a factor in maintaining sterility of an item, since the date determines when it is no longer sterile.
4. Aluminum foil can be used as a packaging material for both EtO and steam sterilization.
5. Textile wrappers, such as muslin, can be laundered as often as necessary without concern to the fabric's integrity.
6. Containerized systems can be used for instrumentation, as well as surgical linen, since guidelines do not state differently.
7. All items to be sterilized must be thoroughly cleaned prior to packaging for sterilization.
8. Materials used for the packaging and wrapping of sterile supplies must be compatible with the sterilization process.
9. Paper, plastic, and a combination of the two are available in various sizes for packaging supplies. These products are not suitable for both steam and EtO gas sterilization.
10. Paper and plastic wrappers may be either heat sealed or sealed with pressure-sensitive tape that indicates by changing color that the package has been subjected to the sterilization process.
11. Achievement of sterilization of supplies is directly related to the preparation and packaging of those supplies.
12. To prevent loss, instruments must remain assembled and in a closed position during sterilization.
13. Paper and plastic wrappers are suitable for steam or gas sterilization.

14. Muslin must be laundered and patched and does not maintain sterility for prolonged periods of time.

15. Reusable container systems are designed to extend shelf life and to eliminate the need for wrapping items in preparation for sterilization.

MULTIPLE CHOICE

16. Packaging materials:

- a. may be any type of paper or plastic that you can find.
- b. must be compatible with just gas sterilization, since anything can be processed through the steam sterilizers.
- c. used for steam sterilization must not permit air removal.
- d. must be compatible with the sterilization process.

17. The minimal accepted thread count for muslin is:

- a. 160 threads per square inch.
- b. 190 threads per square inch.
- c. 240 threads per square inch.
- d. 140 threads per square inch.

18. Container systems have a shelf life of:

- a. 4 months.
- b. 16 months.
- c. 12 months.
- d. 24 months.

19. Nonwoven and woven wrappers can be used for which two classic folds:

- a. The box fold and the accordion folds.
- b. The envelope and the criss-cross fold.
- c. The square and the accordion folds.
- d. The envelope and the square folds.

20. Shelf life is determined by which of the following:

- a. The contents of the package, regardless of the wrapping used.
- b. The expiration date affixed at the time of sterilization, regardless of the condition of the package.
- c. The number of times the package has been handled.
- d. None of the above.

STERILIZATION

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Sterilization



Steam Sterilizer

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OBJECTIVES

Following training, the employee will be able to:

1. Explain the characteristics of ethylene oxide.
2. State the permissible exposure limits set by OSHA.
3. Discuss STEL and TWA.
4. Explain monitoring systems.
5. List the personal protective equipment necessary when changing EtO tanks.
6. Discuss the proper handling and storage of EtO tanks.
7. List sterilizers by type.
8. In general, name the component parts of each of the sterilizers.
9. Describe the cycle of the types of sterilizers.
10. Define implants.

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STERILIZATION

1. PRINCIPLES

a. Sterilization means the act or process of completely destroying all forms of microbial life. This is an absolute. There is no condition as almost sterile, practically sterile, or sterile to a degree. The medical center practice for sterility must be all or none. There can be no in between. Sterility must be measured by proper sterility tests and methods. Achievement of true sterilization is a function of probability, and the process is influenced by the laws of chance. Many factors that can influence the end result of sterilization are:

- (1) The number of organisms and their resistance to the sterilization agent.
- (2) Debris left on the item to allow protection to the organisms, such as protein soil, oils, grease, blood, etc.
- (3) Sterilizer functional efficiency. Proper function.
- (4) Shortcuts used to increase productivity.
- (5) The human element. Performance of people cleaning, packaging, and monitoring the sterilizers.
- (6) Proper loading techniques.
- (7) Handling techniques after the process.
- (8) All parameters of each method of sterilization must be achieved.

b. Sterilization is a complex process and there is no practical way of proving that an item is actually sterile without contaminating it. It is then necessary to verify that an item has been exposed to a processing cycle in a sterilizer. To verify the sterilizer cycle certain tests and monitoring procedures are necessary.

2. STEAM STERILIZATION

a. Moist heat in the form of saturated steam under pressure is the killing agent used in steam sterilization to destroy all forms of microbial life, including viruses and spores. Steam, the vapor into which water is converted when heated to the boiling point, is a combination of heat, energy and water. Heat energy will destroy microorganisms, but steam, or moist heat, will destroy microorganisms at a lower temperature with less exposure time. By lowering the temperature and limiting the exposure time, the integrity or life of certain medical supplies is greatly extended. The most resistant pathogenic

organism is killed in hot air after an exposure of one hour at 340 degrees F. This same organism is killed at 250 degrees F after a 12-minute exposure in saturated steam.

b. Death by moist heat is caused by coagulating the protoplasm, which is the life blood of the microorganism, thus eliminating reproduction. The coagulating of the microorganism's protoplasm can be compared to the chemical change that occurs in the white of an egg when it is poached.

c. Factors greatly affecting the steam sterilization process are: surface contact, time-temperature, and temperature-pressure.

3. SURFACE CONTACT

Effective steam sterilization is dependent on the ability of the steam to have direct contact with all surfaces, including every strand, fiber, or particle of the device or product being sterilized. There are several conditions that can inhibit sterilant contact. Inadequate air removal from the sterilizer chamber, which will prevent steam from contacting all surfaces of the product being sterilized. Steam does not mix with air, therefore, air will act as a barrier between the steam and the surface to be sterilized. Improper handling techniques before the actual sterilizing process can greatly affect sterilant contact. All items must be cleaned properly and placed in the sterilizer in such a manner to aid sterilant contact and not impede it.

4. TIME-TEMPERATURE

a. The time-temperature relationship is necessary to accomplish terminal sterilization in saturated steam. The minimum time to kill known quantities of the most resistant forms of microbial life at various temperatures have proven to be as follows:

30 minutes at 250 degrees F

4 minutes at 270 degrees F

As the temperature increases, the kill time is decreased.

b. The exposure period in a steam sterilizer is the total of heat up minutes, kill time minutes, and safety-factor minutes. The heat up minutes is the time required for the load contents to come to temperature, AFTER the chamber has reached the selected sterilizing temperature and all the air has been removed from the chamber.

5. TEMPERATURE-PRESSURE

a. Pressure does not kill microbial life, but is used in sterilization only to increase temperatures. At sea level atmospheric pressure, water freezes at 32 degrees F and boils at 212 degrees F. Higher or lower pressure will change these values. At an elevation of 5,000 feet above sea level, water will boil at approximately 190 degrees F

instead of 212 degrees F, because of the lower atmospheric pressure. Depending on pressure, water will boil anywhere from 35 degrees F to 704 degrees F. Pressure increases the saturated steam temperature so that it is possible to reach the necessary kill-temperatures to destroy the most resistant forms of microbial life.

b. There is a constant relationship between temperature and pressure for the proper steam quality. If the temperature is raised or lowered, then the pressure must be raised or lowered. It is important to note that the geographic location where the sterilization process is taking place affects the pressure required to reach the kill temperature. Pressure must be increased by .5 pounds for each 1,000 feet above sea level. This increased pressure compensates for the decreased atmospheric pressure.

6. STEAM QUALITY

a. The efficacy of the sterilization process can be affected by the quality and purity of the steam being used. Steam quality refers to the moisture content of the steam. Sterilization failure can result if the steam is either too "wet" or too "dry." Sterilization failure can also result if the steam is not pure. Steam purity refers to the degree of solid, liquid, or vapor contaminants in the steam.

b. Steam used in sterilization is known as Saturated steam. It is necessary to have saturated steam, which is 97 percent dry with a 3 percent moisture content, for effective steam sterilization. Saturated steam has a constant relationship between temperature and pressure. The temperature of saturated steam cannot be reduced or increased without reducing or increasing the pressure.

c. Saturated steam subjected to temperature increases without the corresponding pressure increase becomes superheated steam. Superheated steam is 99 percent dry steam with a 1 percent moisture content. Superheated steam is "dried out" and does not have the necessary moisture content that is so important for the steam sterilization process. If superheated steam is used for sterilization, fabrics can become scorched or burned. Using superheated steam can result in sterilization failure. Sterilizing fabrics that are too dry may cause superheating because the dry fabric will absorb excess amounts of moisture. Fabrics should be laundered and rehydrated between each sterilization process or if the item becomes outdated on the shelf. Fabrics should never be ironed. Ironing causes the fabric weave to tighten which would inhibit steam penetration. Ironing dries out the fabric which causes it to absorb excess amounts of moisture which results in superheating. Outdated linen packs should never be "sprinkled" with water and resterilized. They must be laundered and rehydrated.

d. If saturated steam is subjected to temperature decreases without the corresponding pressure decrease, it becomes wet steam. Wet steam is 91 percent dry steam with 9 percent moisture content. Wet steam may occur at peak operation periods when the excessive demand placed on the boiler may lower temperatures. Improper trapping of the steam line to the sterilizer permits a buildup of moisture in the lines immediately adjacent to the unit, or an uninsulated line allows the steam in the line to

cool, producing excessive moisture. Steam with a high moisture content can cause wet packs in the sterilization process. Water provides a direct pathway for microorganisms. Packs that are wet will not maintain sterility and must not be used.

e. Steam sterilization can be affected by impure steam, which contains solid, liquid, or vapor contaminants. The steam may be considered sterile (it does not contain microorganisms), it is far from "pure." Impure steam can cause linen spotting and instrument staining. Causes of impure steam are:

(1) Solid impurities - rust, pipe scale deposits, sludge, particles from gasket materials, etc.

(2) Liquid impurities - boiler feed water additives used to control the pH level and to retard scale and corrosion.

(3) Vapor impurities - volatile amine additives used to prevent corrosion in steam lines and condensate return lines.

f. Steam impurities may result from steam reacting with additives in wrapping material. If linen is not rinsed thoroughly or if treated with chemicals not compatible with steam, impurities will result. If problems arise that appear to be caused by steam impurity, it is important to determine the source of the problem. Discussing the problem with Engineering Service, boiler maintenance workers, sterilizer manufacturer, or the laundry plant manager, may help in discovering the source of the problem. Once the problem is discovered additives may need to be changed, filters installed, etc.

7. BASIC STERILIZER FUNCTION

Two basic steam sterilization cycles are the Gravity Displacement Cycle and the Prevacuum Cycle. The steam sterilizer consists of ten basic parts:

- a. Door
- b. Jacket
- c. Chamber
- d. Steam Inlet
- e. Chamber Drain
- f. Pressure Gauge
- g. Temperature Gauge
- h. Operator Controls
- i. Mechanical Monitoring Controls
- j. Vacuum Pump (for use with the prevacuum units only)

8. GRAVITY DISPLACEMENT CYCLE

a. Steam is first injected only into the jacket until pressure at the proper range has been reached. This pressure is maintained throughout the sterilization cycle. This process heats the sterilizer chamber which prevents condensation from forming on the otherwise cool interior chamber walls which would consequently cause wetting of the load.

b. Then the cycle is initiated, the chamber and contents are full of air. The chamber drain is open. Steam is injected through the steam inlet valve, usually located near the upper back section of the sterilizer chamber. Because air is nearly twice as heavy as steam, it is pushed or displaced to the bottom of the sterilizer and out through the chamber drain line as the volume of steam is increased. Steam penetrates throughout the load slowly as it displaces the air. It is important to remember this concept of top to bottom flow of steam. If the items are not packaged correctly or the sterilizer is not loaded correctly, air may become trapped because the steam cannot push it out.

c. Steam will continue to enter the sterilizer chamber during the gravity cycle until the thermometer, located in the chamber drain line, registers the preselected temperature. The thermometer is located in the chamber drain line since it is the last area to be reached by steam and the coolest area.

d. The exposure phase is next. Once the thermometer registers the correct temperature, the timing mechanism will be activated, the steam inlet valve and the chamber drain valve will close, and the preselected exposure time will begin. If a drop in the temperature is registered, the steam injection valve will open and add steam into the chamber. Once the correct temperature is maintained, the steam inlet valve will again close.

e. Once the exposure phase is complete, the exhaust phase begins. Steam is quickly exhausted to atmospheric pressure. Sterile filtered air is mechanically injected into the chamber to aid in the cooling and drying of the load contents. At the end of this phase, the chamber door is opened slightly, leaving the cart with the sterile items inside the chamber to continue the drying process. At the end of the cycle, after the door has been ajar, the cart is moved to the cool down area where the items continue to cool.

9. PREVACUUM CYCLE

a. In this cycle, steam is first injected only into the jacket until pressure at the proper range is reached, and this pressure is then maintained throughout the sterilization cycle. This process heats the sterilizer chamber which prevents condensation from forming on the otherwise cool interior chamber walls which would consequently cause wetting of the load.

b. The conditioning phase begins with an initial purge. Steam is injected through the steam inlet valve which displaces the air to the bottom of the sterilizer and out through the opened chamber drain line. The initial purge is followed by a series of steam pulses and vacuum pulls.

(1) **Steam Pulse.** The chamber drain valve is closed and steam is injected through the steam inlet valve.

(2) **Vacuum Pull.** The steam inlet valve is closed and the air/steam is pulled from the chamber and load by the use of a powerful vacuum pump which creates a negative pressure within the sterilizer chamber and load.

c. The pulse/pull sequence consists of three steam pulses and four vacuum pulls. Packaging and loading are less likely to interfere with air removal in the prevacuum cycle because the vacuum pump pulls the air from the items to be sterile. It is still vital to follow correct loading techniques, as is done for all sterilizers utilized.

d. After the last pull, there is negative pressure within the chamber and items to be sterilized. When steam is introduced into this vacuum, it penetrates the chamber and load quickly in a very turbulent manner since it is not impeded by air. Steam will continue to enter the sterilizer chamber until the thermometer located in the chamber drain line registers the preselected temperature.

e. The timing mechanism will be activated at this point, the steam inlet valve and the chamber drain valve will close, and the exposure time will begin. If the thermometer registers a drop in temperature, the steam injection valve will open and steam will be injected into the chamber. Once the temperature is reached, the steam inlet valve will again close.

f. Upon completion of the exposure phase, the steam is mechanically removed by the vacuum pump. Sterile filtered air is then mechanically injected into the chamber to relieve the vacuum. Once the cycle is complete, the door is opened and the cart, with the dry items, is moved to the cool down area where the sterile items continue to cool.

10. FLASH STERILIZATION

a. The philosophy behind "flash" sterilization has been accepted for years. Recommendations from JCAHO, AMMI, and AORN now state that flash sterilization should only be used in an emergency. This is for items that are dropped and/or single instruments that may be called for during a case, that are not already sterile. It is not recommended, however, to flash large trays of instruments, such as loaner trays or to flash IMPLANTS.

b. If loaner trays and implants are to be used for a case, they should be received into SPD in advance of the scheduled case and properly cleaned, assembled, sterilized and

quarantined. (Implants only are to be quarantined. Remember, screws and plates in orthopedic trays are considered implants.) It is imperative that the medical center develop a protocol for handling instrument trays that are used on a loaner basis. This needs to be accomplished by the Chief, SPD.

c. If an instrument set is needed for another case scheduled for the same day, enough time must be allocated by the operating room to send their set of instruments to SPD for decontamination and sterilization. Instruments should not be cleaned in the operating room by scrub nurses, then flashed. This practice will lead to cross-contamination, and can cause grave outcomes with the patient. It is the responsibility of the Chief, SPD, and the Operating Room Manager to determine if additional sets of instruments are necessary to avoid reprocessing and sterilization of instrument sets needed for another case for the same day.

d. Flash sterilizers are basically gravity displacement sterilizers set on the "open" cycle or nonwrapped cycle. The items to be flashed should be placed within the tray to avoid overcrowding and should not be overloaded. There should be no towels in the tray. Items with lumens, such as suction tubes, will not be flashed and power equipment should never be flash sterilized, due to their complex makeup.

e. All sterilizer cycles should be monitored. Monitoring sterilization cycles will be discussed later in this chapter.

f. All sterilization cycles require accurate documentation and record keeping. This includes all flash sterilization loads. All items processed through the cycle should be listed, along with the sterilizer number, load number, date, and print out or graph from the sterilizer. The Chief, SPD, will be required to track all sterilizer loads processed in the operating room as well as within the medical center.

11. EtO (ETHYLENE OXIDE) STERILIZATION

a. EtO gas has been an effective sterilant for heat and moisture sensitive medical devices for more than a quarter century. However, because of its toxic nature, EtO must be used with caution and only by individuals properly trained in its safe use.

b. The process of alkalization inactivates the cell, causing a chemical interference which disrupts the reproductive process of the microorganisms, thus destroying them. Hence, sterilization is achieved. It is recommended that ONLY heat sensitive items be EtO sterilized, only items that ABSOLUTELY cannot be sterilized by steam. EtO sterilization is expensive and too time consuming to tie up needed medical supply items.

c. All items processed in EtO must be thoroughly cleaned and dried prior to sterilization. If water and EtO mix during the cycle, a by-product, polyglycol is

produced. This byproduct can be hemolytic, or in other words can destroy blood cells. Always assure all items have been properly dried prior to sterilization.

d. Two types of ethylene oxide sterilizers are most commonly used. They are table top or smaller chamber stand alones that utilize 100 percent EtO cartridges, and the larger units that utilize the most common EtO mixture of 88 percent freon and 12 percent EtO. A well designed ventilation system must be in place when using either method. The EtO mixture containing freon will no longer be allowed for use in any facility due to the chloroflorcarbins (CFC's), admitted into the atmosphere, so many facilities are looking to other methods to sterilize heat sensitive items. Many of these methods are still in the testing phase, and it is recommended to research these new sterilizers in depth, prior to purchasing them. More information on these sterilizers will be discussed later in this chapter.

e. Many of the existing EtO sterilizers in use consist of the following phases:

(1) Vacuum phase, which creates a partial vacuum drawn for a brief time, to remove most of the residual air from the chamber and from the packaged items in the load. Once the desired vacuum has been reached, steam is injected into the chamber and diffuses throughout the load, beginning a 20- to 30-minute conditioning period, during which the contents of the load reach a relative humidity of 50 to 75 percent and the desired temperature is reached.

(2) The ethylene oxide gas or gas mixture is admitted, and as the sterilant is injected, the chamber pressure rises to the pressure required to achieve sterilization.

(3) The sterilizer then remains in the exposure phase for the preset time. The chamber is continually maintained at the correct pressure, humidity, and temperature. Once this phase is completed, a vacuum is pulled (sometimes called the "purge" cycle), removing the gas from the chamber and exhausting it to the outside atmosphere.

(4) Once this phase is complete, or the chamber is exhausted, air is drawn into the chamber through a bacteria retentive filter and then reevacuated from the chamber, removing most of the ethylene oxide. This air wash is continued for a period of 10 to 30 minutes.

(5) At the end of this phase, the chamber is returned to atmospheric pressure. Some sterilizers continue the filtered air purge until the door is opened.

f. Many EtO sterilizers are equipped with an aeration cycle at the end of the sterilization cycle. This allows the load to completely aerate prior to opening the door or touching the items. This is the safest way to EtO sterilize. If there is not an aeration cycle at the end of the sterilize cycle, the door must be cracked for 15 minutes and all staff should remain away from the area. Once the time is completed, the load may be moved to the aerator.

g. To move a load to the aerator, the sterilizer operator should always remember to pull the load, never push it. Pull the cart to the aerator, then slide the load into it, close the door and begin the cycle immediately. All items sterilized by EtO must be aerated. Typical aeration time and temperature is 12 hours at 122 degrees F, but the manufacturer's instructions should always be consulted. Items that are not properly aerated can cause burns to the patient, physician, or staff handling the item.

h. Room aeration, or ambient aeration, is not recommended. With ambient aeration, items are placed in an isolated, well ventilated room and the gas allowed to dissipate slowly over a period of time, usually several days.

12. LOADING THE EtO STERILIZER

a. The packaged items to be sterilized should be placed on metal sterilizer carts or in wire baskets. The use of metal carts minimizes handling of sterile items and, because metal does not absorb ethylene oxide, allows safe transfer of items from the sterilizer to the aerator.

b. When the items are loaded on the cart, they should be arranged loosely to ensure the sterilant will circulate freely and reach all surfaces. The items must not touch the sterilizer chamber walls during the cycle. Loading the EtO sterilizer should be done in much the same manner as loading the steam sterilizer.

13. STERILIZATION MONITORING

a. Because such a variety of parameters must be met to achieve sterilization, monitoring the process is essential. The methods used for monitoring the sterilization process are chemical, biological, and mechanical.

b. Chemical indicators consist of paper chemically treated to change color when subjected to the sterilization process. There are internal and external chemical indicators.

c. Internal chemical indicators are placed inside packages. The internal chemical indicator alone does not guarantee sterility, but provides an indication to the user that the contents of the package were subjected to sterilizing conditions. However, if the indicator has not completely changed its color, the contents may not have been subjected to a full scale sterilizing process and, therefore, should not be considered sterile.

d. External chemical indicators are placed on the outside of packages and are commonly used as package closure, as in the case of sterilizer tape. External chemical indicators also do not alone guarantee sterility, but that the package has been exposed to a sterilizing cycle. The external indicators must be examined for proper complete color change after sterilization and again prior to distribution to eliminate the possibility of distribution of items not processed.

e. Another test performed, but only on prevacuum sterilizers, is the Bowie-Dick test (named for the scientists who invented it). These test packs can be assembled in SPD or purchased preassembled from the manufacturer. The Bowie-Dick test is performed daily according to the manufacturer's instructions to test the effectiveness of the vacuum system. It is not a sterilization test. The packs contain a chemical indicator which turns color when an effective vacuum has occurred. The packs should be placed in the sterilizer on the bottom rack over the drain in an otherwise empty chamber. This area is chosen because it is the most difficult area in the chamber to create an effective vacuum. At the end of the cycle, the indicator within the pack is examined for a uniform color change to indicate a complete vacuum within the chamber.

f. A biological indicator contains live spores and provides a further indication of an effective sterilization process. *Bacillus stearothermophilus* are the spores used in steam sterilization and *Bacillus subtilis* are used in EtO sterilization.

g. The biological indicators contain an amount of spores that far exceeds the amount of bioburden possibly left on items after the decontamination process and before sterilization. The sterilization process is designed to kill the excessive amount of spores within the biological indicator and, therefore, provide a margin of safety.

h. Biological indicators are placed in a fully loaded chamber and run with every EtO sterilization cycle. They are run in a fully loaded steam sterilization cycle once a day, with every load containing an implantable device, and after each major repair of the sterilizer. After the cycle, the indicator is incubated either in the lab or, if appropriate, in SPD. Steam biological indicators are incubated at 55 degrees C and EtO biological indicators at 37 degrees C. Both are incubated for 48 hours. At 48 hours, the indicators are examined. If they show a color change, this indicates growth of the spores and, therefore, a kill was not obtained and the sterility of the load not indicated. When the color does not change, this indicates no growth and that sterility was achieved. A "control" indicator should be processed daily for each type of sterilization (steam or gas) to assure that the spores are viable. These controls must be from the same lot number as the test biologicals.

i. In the event of a positive biological indicator, it must be determined whether it was due to sterilizer malfunction, user error, or contamination of the indicator following sterilization. If sterilizer malfunction or user error is determined, the load must be recalled, reprocessed, and resterilized. All items bearing the load number of the load containing the positive microorganisms other than *Bacillus stearothermophilus* or *Bacillus subtilis* within the indicator, contamination after sterilization and prior to incubation is assumed.

j. Mechanical monitoring is accomplished by gauges, recorders, graphs, etc., that indicate the proper sterilization parameters have been met. This may either be done manually or by automated readouts, depending on the sterilizer equipment. Both manual and automatic monitoring must be verified at the completion of each sterilization cycle.

k. Records must be kept of all sterilization monitoring done in the medical center. The contents of each load, the operator, the length, temperature, and other required parameters must be documented for each load run in both steam and EtO sterilizers. The results of the Bowie-Dick tests and the biological indicators must be documented as well.

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STERILIZERS

1. TYPES OF STERILIZERS

a. There are several types of equipment used for terminally sterilizing medical supplies and equipment. Types of sterilizers to be discussed include prevacuum steam, gravity displacement steam, ethylene oxide, dry heat, chemical, and plasma sterilizer.

b. Steam and ethylene oxide sterilizers are the two most common units used in hospitals and clinics. Those units are preferred because the sterilizers are effective in killing microorganisms and are relatively inexpensive. There are several variations of each type of unit, they vary in size and function.

c. Personnel must be trained thoroughly before they operate any sterilizing equipment. Operating a sterilizer is a demanding part of the SPD technician's job. If it is not done properly, the instruments or supplies used may cause infection to the patient.

2. STEAM STERILIZERS

a. Steam under pressure is one of the most reliable methods for sterilizing items that can withstand high temperatures and moisture. Steam is very effective in killing microorganisms. It is relatively easy to produce, inexpensive, and the process can be effectively monitored.

b. **Prevacuum Steam Sterilizers.** Component parts consist of a double walled (jacketed) chamber, a pressure door (depending on the model, the door can be manually or automatically operated), a control panel, and monitoring gauges. The unit can come in different sizes, from a large floor model to a unit capable of handling only a few supplies. The unit is connected to a steam fed system, as well as a steam condensing system that converts the steam into water following the sterilizing operation. The water is discharged into a floor drain. The body of the sterilizer can be encased in a stainless steel cabinet, however, the plumbing and the body of the sterilizer are usually contained in a dedicated room, only the door, control panel, and gauges are visible to the staff. Processing temperature for this equipment ranges from 250 degrees F to 275 degrees F. Each sterilizer cycle consists of several phases. A typical prevacuum cycle is as follows:

(1) Phase 1 – Prevacuum 1 – a vacuum is pulled to remove the air from the chamber and the interior of the packages. In this phase most of the air is removed from the chamber.

(2) Phase 2 – Exposure – the length of time and temperature of this phase is predetermined by the operation. The chamber temperature is maintained when additional steam is injected into the chamber to replace cooled steam.

(3) Phase 3 – Come down – at the end of the sterilize phase, the bottom drain opens and allows the steam to evacuate the chamber.

(4) Phase 4 – Drying – at atmospheric pressure, the drying phase is begun. The jacket temperature aids in the drying of the load. Gravity-displacement sterilizing is a much longer process than prevacuum sterilizing. When the determined time is over, an audio and visual alarm sounds. The cycle is completed. Large, dense packs will take longer to process because of the extended time for air to be removed from them.

f. Liquid loads should always be run on a gravity cycle. This cycle however, is somewhat different from the cycle described above. Liquids take longer to run. Generally a cycle is as follows:

(1) Phase 1 – Come up – the drain at the bottom of the chamber and a valve at the upper part of the chamber open and steam is injected into the chamber. As the steam concentration increases, the air in the chamber is forced out through the bottom drain. The steam will continue to be forced into the chamber until the predetermined temperature is reached.

(2) Phase 2 – Exposure – the length of time and the temperature of the phase is predetermined. The chamber temperature is maintained when additional steam is injected into the chamber to replace cooled steam.

(3) Phase 3 – Come down – at the end of the sterilize phase, the bottom drain opens in gradual increments. This is done so that the pressure can be released slowly to allow for the liquids to cool. This process can take up to 30 minutes or longer, depending on the load contents. After the cycle, the temperature must be allowed to drop to at least 200 degrees F before the chamber door can be opened. The technician must use great care when handling containers of liquids following sterilization. The contents can boil over or explode and injury may occur. Extreme care must be used when running liquid loads. All operating instructions must be strictly followed when operating a liquid cycle.

NOTE: No other items should be run with liquids. Select the temperature 250 degrees F. Exposure time is based on the amount of liquid in the container. No dry time is to be set.

h. **Table Top Steam Sterilizers.** These types of gravity-displacement sterilizers are usually found in dental offices or clinics. It is a small unit that can be placed on a counter. The unit has an electric generator that turns water into steam. The air is

forced out of the chamber and steam is injected into the chamber for a predetermined time.

3. DRY HEAT STERILIZERS

a. This method of sterilization uses air at elevated temperatures to sterilize. The principle of the operation is that hot air is circulated over items for specific periods of time. The amount of time needed to sterilize an item will depend on the temperature selected. The microorganism and the cellular debris are literally burned up during the process.

b. These sterilizers are used to sterilize instruments (which includes suture needles), glassware, some types of powders, and petroleum base gels.

c. However, sutures, most types of powders, and gels can now be purchased pre-sterilized. There are two types of dry heat sterilizers – gravity and mechanical.

d. **Gravity Dry Heat Sterilizer.** The heating element is at the bottom of the unit. As heat rises, it heats the instruments to the desired temperature. This continues until the unit times out.

e. **Mechanical Dry Heat Sterilizer.** This unit works essentially the same as the gravity unit except that it has a system that recirculates the air through the sterilizing chamber. This unit heats the load more evenly. The sterilizing process with this unit is more controlled.

4. ETHYLENE OXIDE STERILIZER

a. This type of sterilizer is used to sterilize heat and moisture sensitive items. Ethylene oxide (EtO) is a toxic substance and a cancer and reproductive hazard. Technicians must follow all work practices designed to minimize any contact with EtO.

b. **Ethylene Oxide 12/88 or 10/90 Mixture.** Component parts consist of chamber, pressure door (depending on the model, the door can be manually or automatically operated), a control panel, and monitoring gauges. The unit can come in different sizes, from a large floor model to a unit capable of handling only a few supplies. The unit is connected to a steam fed system, as well as a steam condensing system that converts steam and sterilant into a liquid that is discharged into a floor drain. The sterilizer uses a gas mixture 10 or 12 percent by weight, ethylene oxide, and a carrier gas chlorofluorocarbon 88 or hydrochlorofluorocarbon 90 percent by weight. This mixture is fed into the sterilizer from gas cylinder(s). The body of the sterilizer, plumbing, and cylinders are contained in a dedicated room under negative pressure. Only the door, control panel, and gauges are visible to the staff. The purpose of a dedicated room under negative pressure is to reduce employee exposure to EtO. Some SPDs have

installed an additional room around the door. This area is also under negative pressure. A typical EtO cycle would be as follows:

(1) Phase 1 – Vacuum/Conditioning – the bottom drain in the chamber opens and a vacuum is drawn. When the proper pressure level is reached, steam is injected into the chamber and the load is moistened. This is referred to as conditioning. Conditioning aids in the sterilization process. The conditioning process ranges from 20 to 30 minutes. During this time, humidity of the chamber must reach 50 percent to 75 percent.

2. Phase 2 – Charge – EtO is injected into the chamber until a preset chamber pressure is reached.

(3) Phase 3 – Exposure – the sterilant stays in the chamber for a preset amount of time. During this time, the pressure and humidity are monitored and adjusted automatically. At the end of the cycle, the bottom drain opens and EtO is drawn out of the chamber.

(4) Phase 4 – Air wash – air is injected into the chamber and evacuated out. This process is repeated several times. The air wash phase will vary with the brand of sterilizer. At the end of the cycle, an audio or visual indicator or both will come on. Some sterilizers will reintiate the air wash phase if the machine is not attended to in a specified time.

c. Developments in new EtO mixtures. Many Central Services or SPDs have used ethylene oxide/chlorofluorocarbon- 12 (EtO/12/88) for many years. However, it has been determined by the Environmental Protection Agency (EPA) that CFCs are harmful to the atmosphere and will no longer be available as a carrier gas for use with EtO after 1995. Alternatives to EtO/CFC include EtO/hydrochlorofluorocarbon (EtO/HCFC) and EtO/carbon Dioxide (EtO/CO₂). EtO/HCFC mixture is now being marketed. However, HCFC is also a form of fluorocarbon and is scheduled to be phased out in the year 2030 or as early as 2015. In order to utilize this mixture, there must be modifications to the EtO sterilizer. EtO/CO₂ mixture is more desirable because the carbon dioxide is not harmful to the atmospheric ozone. The initial cost of the system is considerably higher than the HCFC because a weight sensing load station must be installed for use with the gas cylinders.

5. STERILIZER/AERATOR COMBINATION

Some manufacturers offer an aerator function built into the EtO sterilizer. At the end of the sterilize phase, the unit will automatically start a pre-programmed aeration phase. The standard times for aeration are 8 to 12 hours. The benefit of this type of unit is that the operator does not have to handle supplies until after aeration.



Sterilizer/Aerator Combination

6. 100 PERCENT ETHYLENE OXIDE STERILIZER

a. This type of sterilizer is often referred to as a table top sterilizer. The unit uses 100 percent EtO dispensed from a cartridge. The unit is connected to a dedicated exhaust. A typical cycle is as follows:

- (1) Phase 1 – Conditioning – the load is moistened with steam for a predetermined time.
- (2) Phase 2 – Exposure – EtO is injected into the chamber causing pressure to increase for a predetermined period of time.
- (3) Phase 3 – Aeration – EtO is evacuated from the chamber followed by an air wash.

b. As discussed earlier in this section, instruments and supplies that are sterilized by EtO must be aerated. The 100 percent EtO sterilizer may come with the option to perform an aeration function. If not, the operator must remove the load following sterilization, the load must be transferred to a mechanical aerator.

7. MECHANICAL AERATION

a. Component parts consist of a chamber and door, control panel, and a heater/blower unit. The body of the unit is usually located into a dedicated room under negative pressure. The door and control panel are set flush against the wall separating the work area from the dedicated room. De[pend]ing on the manufacturer, the unit may come with one or more temperature selections.

b. Following EtO sterilization, all items must be aerated for a specific amount of time. As outlined in MP-2, Subchapter E, sub-part 108-76.303(b) through (d):

“(b) The Chief, SPD, will establish written minimum aeration periods for all EtO sterilized items. Specific aeration recommendations should be obtained from the device manufacturer.

(c) The following is the minimum aeration time for eliminating EtO residuals in the absence of specific recommendations by the device manufacturer: Aeration in an approved cabinet at 50 degrees Centigrade (122 degrees Fahrenheit) for 12 hours.

(d) When in doubt about aeration requirements for a particular device, the time (12 hours) shown in (d) of this section may be followed. However, some materials may require even longer periods of aeration so the device manufacturer should be consulted for specific recommendations. Ambient or room temperature aeration is not authorized.”

c. A typical aeration cycle is as follows: Once the temperature and time are set, warm air is circulated into the chamber for the predetermined time. During the cycle, air in the chamber is continuously evacuated out and into a dedicated exhaust vent. Additional air is pumped into the chamber. This cycle continues throughout the aeration period. The supplies and instrumentation aerating must stay in the aerator the full cycle time. They must **NEVER** be removed before the cycle is complete.

8. NEW TECHNICAL DEVELOPMENTS IN STERILIZATION EQUIPMENT

a. In the past few years two new types of sterilizing equipment have come on the market. These units are chemical sterilizers (peracetic acid) and plasma sterilizers.

(2) **Chemical Sterilizer.** Component parts of the system include the processor unit with a built in control panel, a recording/printing device, and various sized inserts and instrument trays. This system employs peracetic acid and sterile water to clean and sterilize heat sensitive and/or immersible items. This unit can only sterilize one scope at



EtO Aerator

a time or a small instrument tray. The instrument containers cannot be sealed so the instrument set cannot be stored for future use. Therefore, instruments sterilized by this method must be used immediately after sterilization. The sterilizer operates at 50 degrees C to 55.5 degrees C and achieves sterilization in 30 minutes or less (20 minute minimum). The system can be used to process flexible and rigid scopes, microsurgery instruments, and general hard goods.

(2) **Plasma Sterilizer.** Sizes of plasma sterilization chambers vary from 2.5 to 5.0 cubic feet. The plasma sterilization process involves microwaves and a chemical compound.

b. In general terms the process is as follows: The chemical compound is turned into a vapor. The vapor passes through an electromagnetic field. Electrons are stripped from some of the atoms, accelerating the charged particles. This reaction creates a

variety of other species (particles) that kill microorganisms, including bacteria spores, by disrupting their cell membranes. The entire process is achieved in about one hour. There is no residual from the chemical so aeration is not required. The system is limited, as it is not designed to sterilize cellulose based items such as linen and paper. Examples of items that can be processed in a plasma sterilizer are rigid and flexible scopes, surgical and microsurgical instruments, surgical power equipment, glassware, etc.

ETHYLENE OXIDE (EtO)

1. HEALTH HAZARDS OF EtO

a. Items that are sensitive to extremes in temperature, pressure, or moisture may require gas sterilization utilizing EtO rather than steam sterilization. EtO is a colorless gas with an ether-like odor. Coming into contact with EtO has caused cancer in laboratory animals and has been associated with higher incidents of cancer in humans. In addition, adverse reproductive effects, chromosome damage, and neurotoxicity may also occur from EtO exposure.

b. In its liquid form, EtO exposure can cause eye irritation, lung injury, headaches, nausea, vomiting, diarrhea, shortness of breath, and cyanosis (blue or purple coloring of the skin).

2. PERSONNEL MONITORING

a. Due to the health hazards associated with exposure to EtO, the Occupational Safety and Health Administration (OSHA) requires periodic monitoring of employees who work around EtO. permissible exposure limits have been set by OSHA and are found in 29 CFR Section 1910.1047. There are two levels to be concerned about. The Short Term Excursion Limit, or STEL, requires that no employee will be exposed to an airborne concentration of EtO in excess of 5 parts of EtO per million parts of air (5 ppm), as averaged over a 15-minute period. STEL monitoring is normally taken during those times when the possibility of exposure is high, such as during tank changes and maintenance on the EtO sterilizers. An 8-hour Time Weighted Average (TWA) has also been set to ensure no employee has been exposed to airborne concentrations in excess of 1 part per million (1 ppm) during an 8-hour period.

b. Representative samples of both the 15-minute short-term exposures and the 8-hour time weighted average of EtO concentration is at or exceeds the action level of .5 ppm, but at or below the TWA of 1 ppm, monitoring for each such employee must be repeated at least every 6 months. If the initial monitoring reveals employee exposure above the 8-hour TWA of 1 ppm, the exposure problem must be remedied and the exposure levels reduced below the 8-hour TWA. Monitoring of these employees must be repeated at least every 3 months. If the 15-minute STEL is above 5 ppm, the exposure problem must also be remedied and monitoring for such employees will be repeated every 3 months. If it can be demonstrated by two consecutive measurements taken at least 7 days apart that employee exposures are below the action level of .5 ppm TWA, the frequency of monitoring for these employees can be discontinued.

c. Additional monitoring is required whenever there has been a change in the production, process, control equipment, personnel, or work practices that may result in new or additional exposures. After receiving the results of monitoring, the SPD Chief must notify the employee, in writing within 15 working days, of the results. This can be done either individually or by posting the results in an appropriate location accessible to the employees.

3. MEDICAL SURVEILLANCE

A medical surveillance program must be in place and available to all employees who are or may be exposed to EtO for at least 30 days a year. The medical surveillance will include medical examination and consultations. The medical exam will be made available to the employee: prior to assignment in SPD, at least annually, at the termination of employment in SPD, as medically appropriate for any exposure at the employee's request, and as soon as possible after potential exposure to EtO.

4. AREA MONITORING

Although not required by OSHA, many VA hospitals have installed systems to detect concentrations of EtO in the air. This is most often accomplished periodically by utilizing personnel monitoring badges. If an area monitoring system is used, the best method of EtO detection is by gas chromatography that is EtO-specific. Many area monitoring systems are available which are not EtO-specific, but will alarm merely with the presence of hydrocarbons which can be found in many cleaning solvents and alcohol. In order to prevent many false alarms in SPD and guarantee the proper response by employees in emergent situations, an EtO-specific monitoring system is necessary. The purpose of these systems is to detect high EtO levels in the work area before employees are exposed to them. Therefore, the alarm levels should be set at or below the exposure levels set by OSHA. Most systems have both a low and a high alarm. The low alarm in the work areas should be set at the action level of .5 ppm so the SPD Chief knows that action should be taken to determine the cause. The high alarm in these areas should be set at the TWA of 1 ppm. In the tank room and equipment maintenance access areas, the STEL is 5 ppm, so the alarm should be set only at this level to notify anyone working there to evacuate immediately. Of course, placement of the sensing ports for the monitoring system is important. It is recommended that a monitoring point be located in any area, directly in front of the EtO sterilizer, at the work stations in the preparation room, and directly in front of the sterilizer in the Decontamination room, if there is access to the EtO sterilizer from there.

5. EtO TANK CHANGING

As mentioned earlier, changing the tanks on the EtO sterilizer represents a high risk of exposure to EtO. Therefore, increased precautions must be taken to prevent

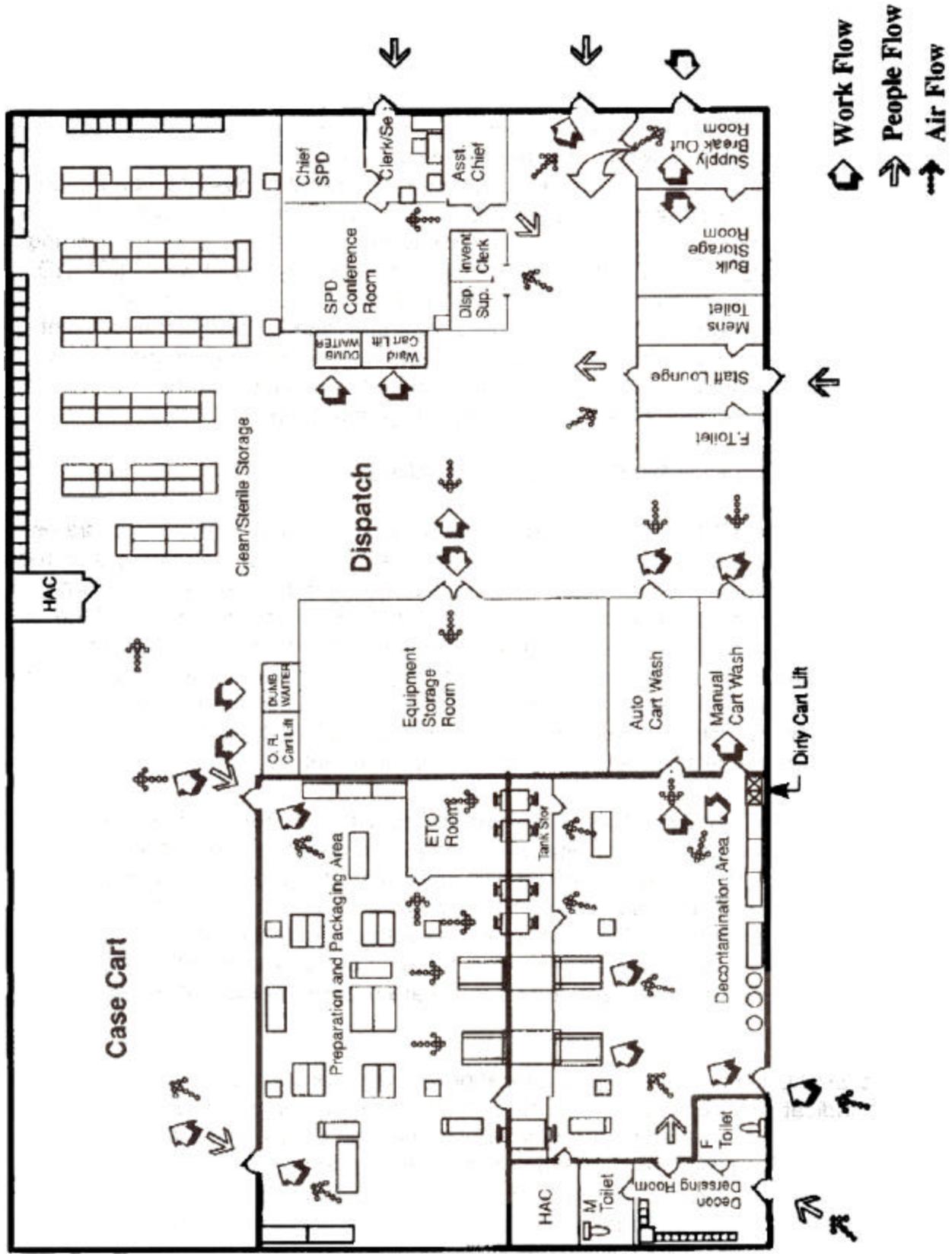
employee exposure to both the vapor and liquid forms of EtO. Personal protective clothing should be supplied and worn when changing EtO tanks, whether they are 100 EtO cartridges or 12/88 or 10/90 EtO tanks. Personal protective clothing worn should include the following: impermeable coveralls or similar full-body work clothing, gloves, head coverings. A full-face piece respirator that has been approved as being acceptable for protection against EtO should also be worn to prevent the inhalation of EtO vapors. Non sparking tools should be used when opening or closing metal containers of EtO. If impermeable clothing or skin becomes wet with liquid EtO, an SPD technician should immediately remove the clothing and EtO while under a shower. Remember, liquid EtO is easily ignited, and care should be taken to prevent any sparks or exposure to heat, flames, or other items which might cause the EtO to ignite. Fire extinguishers and showers should be readily available, and each SPD technician should know where they are and how to operate them.

6. SAFE HANDLING AND STORAGE OF EtO TANKS

a. **100 percent EtO Cartridges.** If each cartridge contents has 50 or more grams of EtO, only one day's supply of cartridges, up to a maximum of 12 cartridges, is stored in the immediate area of the sterilizers. If more than 48 cartridges are stored in the inventory area, then the storage area must conform with the recommendation of the National Fire Protection Association (NFPA). Empty containers are placed along with regular nonincinerated waste. Containers containing EtO will be returned or disposed of in accordance with the manufacturer's instructions. If such containers are not returned to the manufacturer, disposal of the containers will be done in compliance with EtO health and safety requirements and applicable local regulations.

b. **EtO Gas mixture Cylinders.** Cylinders of EtO gas mixtures, such as 88/12 or 90/10, are stored in a temperature regulated designated area that meets building codes and OSHA regulations. Tanks are stored and used in an upright position and are securely fastened in place by suitable straps or chains. Cylinders of EtO gas mixture are transported to and from SPD on cylinder carts with chains securing them during transit. All EtO cylinders are stored in an area away from the flow of traffic. Cylinders which have been used and removed from service are handled in the same manner as full cylinders.

c. The SPD Chief should develop a local policy, with concurrence by the Industrial Hygienist, indicating what steps should be taken in the event of an EtO emergency, and each SPD employee required to attend annual training on EtO, which will include: EtO sterilizer and aerator operation and maintenance, work practice/precautions for safe use of EtO, safe handling and storage of EtO tanks, physical and health hazards, accidental spill/leak plan, emergency first aid procedures, personal protective equipment, and professional EtO monitoring methods.



IMPLANTS

1. **IMPLANTABLE DEVICES. IMPLANTS** are devices that will be surgically implanted and totally contained in the body. Examples of these devices are orthopedic hardware items such as pins, screws, nails, rods, and total joint system replacement hardware; heart valves; cranial shunt and reservoirs; breast and penile prostheses; and micromesh. Implantable devices **will not** be processed by means of flash sterilization. **Every** steam and ethylene oxide gas sterilization load containing implantable devices **will** be monitored with the appropriate biological indicator. After sterilization, these devices will be held in **quarantine** by SPD, and will not be used until the spore test is found to be **negative** (after 48 hours). If an emergency situation should present itself, SPD **will** process the implant as usual and, if an **early release** is necessary, the Chief, SPD, is required to obtain a written approval from the Chief of Staff before releasing the implant from quarantine.

2. **Flash sterilization** is for emergency situations only. Adequate scheduling and planning should be utilized to have the necessary supplies on hand so that proper sterilization procedures are followed, in order not to compromise patient care.

3. **Reprocessing** implants may be necessary at times. It is important to follow the **manufacturer's guidelines** in order not to compromise or alter the implant's intended use. Some manufacturers require special gloves in handling implants and septic cleaning procedures. It is the responsibility of SPD to ensure that reprocessing does not alter the composition of the implant or alter the implant's intended use. The manufacturer will also provide information on how many times the implant can be reprocessed or if it is even possible to reprocess the implant. **Written documentation** from the manufacturer about **reprocessing guidelines** should be available and followed by **all SPD employees**. SPD **must have** a Standard Operating Procedure in order to track the number of times an implant has been used and reprocessed.

4. The **Safe Medical Device Act** became effective on August 29, 1993. The Food and Drug Administration (FDA) mandated that certain medical devices be tracked so that the devices can be located, whether in use or in stock, to notify the users or recipients of serious risk to their health. Implants fall under the medical devices that must be tracked. SPD employees should be familiar with the tracking program their medical center has developed in order to comply with the Safe Medical Device Act.

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STERILIZATION TERMS

Aeration
Aerator
Ambient Aeration
Autoclave
Chromatograph
Dry Heat Sterilizer
Ethylene Oxide (EtO)
EtO Sterilizer
Exposure Time
Guideline
Heat Resistant
Heat Sensitive
OSHA
Peracetic Acid
Plasma Sterilizer
PPM
Prevacuum
Saturated Steam
Steam Sterilizer
STEL
Sterilization
Superheated Steam
TWA
29 CFR 1910.1047

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QUESTIONS - STERILIZATION

1. Steam _____ is one of the most reliable methods for sterilizing items that can withstand high _____ and _____.
2. A jacketed sterilizer is one that is _____ walled.
3. The phases of a cycle for a prevacuum sterilizer includes _____, _____, _____, _____, _____, and _____.
4. _____ should never be run in prevacuum cycle of a steam sterilizer.
5. Dry heat sterilizer cycles use air at _____ to perform sterilization.
6. Generally, the phases of the cycle for 100 percent EtO sterilizer are _____, _____, and _____.
7. Standard aeration times, as outlined in MP-2 Subchapter E, subpart 108-76.303(c), are: 50 Centigrade (122 degrees F) for _____ hours and 60C (140 degrees F for _____ hours.
8. Developments in new EtO mixtures include EtO _____ and EtO _____.

TRUE/FALSE

9. Plasma sterilization cycle leaves residual chemical on instruments, the load must then be aerated before the items can be used.
10. Liquid loads can only be sterilized in a gravity-displacement steam sterilizer with no dry time setting.
11. Dry heat sterilizers are capable of sterilizing some types of powders and ointments.
12. 100 percent ethylene oxide is harmful to the ozone layer of the earth's atmosphere and will be banned from use by the end of 1955.
13. Ambient or room temperature aeration is considered an acceptable method of aerating EtO sterilized items.
14. 250°F and 270°F are two established temperature settings for steam sterilizers.
15. EtO sterilizers are available that can perform both sterilizing and aeration.

MATCHING

- | | |
|---|------------------------------------|
| ___ 16. Recently developed sterilizer technology. | A. dental office or clinic |
| ___ 17. One of the most reliable methods for sterilizing heat and moisture sensitive items. | B. sterilizing |
| ___ 18. Component part of a steam sterilizer that turns steam into water vapor following a cycle. | C. plasma and chemical sterilizers |
| ___ 19. The microorganism and the cellular debris are literally burned up in the sterilizing process. | D. EtO sterilizer |
| ___ 20. Small gravity-displacement sterilizers can often be located. | E. dry heat sterilizer |
| ___ 21. The process that causes the destruction of all forms of microbial life, including the most resistant types of spore-forming bacteria. | F. condenser |

SURGICAL INSTRUMENTATION

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Surgical Instrumentation



Instrument Assembly and Preparation

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OBJECTIVES

Following training, employees will be able to:

1. Recognize the common use instrumentation.
2. Identify instruments for different types of surgical uses.
3. Identify the different parts of instruments.
4. Distinguish the difference between hand-held and powered instruments and flexible and rigid endoscopes.
5. Explain the proper placement of instruments into trays, sets, and containers.
6. Understand the proper stringing of string instruments and how to place instruments on the stringer to assure easy access.
7. Demonstrate testing procedures for all instruments and identify malfunctions.
8. Define the different care and handling aspects for surgical instruments.
9. Discuss recommended processing procedures for all surgical instruments.
10. Demonstrate the proper placement of instrument trays and sets on the sterilization carts.
11. Know the correct storage and transportation for both soiled and sterile instrument sets and trays.
12. Explain the difference between floor grade and surgical grade instruments.

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SURGICAL INSTRUMENTATION

1. INTRODUCTION

a. As surgical technology continues to advance, so does the type and complexity of surgical instrumentation. Surgical instruments are a major investment in the hospital setting and require special care and handling to maintain proper function and longevity. This is dependent solely on how an instrument is used and cared for. The operating room staff, as well as the SPD technicians, are required to use, assemble, and recognize thousands of different types of surgical instruments and devices.

b. Not all facilities are involved in cleaning and sterilization of surgical instrumentation. However, they may be required to assemble special procedure trays for clinics, dental, and special use areas. These areas may utilize surgical grade instruments, versus the ward or floor grade instruments, with the different types of surgical instruments available. Regardless of the type of support offered a medical facility, the SPD technician should be familiar with the different types of surgical instruments in the event the facility decides to include SPD in the care, handling, and assembly of surgical instrumentation.

c. SPD is responsible for inspecting the instruments prior to sterilization to assure the instruments have been cleaned properly, tested, and checked for proper function and damage (cracked box locks, etc.), and assembled according to an accurate and detailed procedure list, agreed upon by the operating room. A damaged instrument should be sent for repair and a replacement placed in the set.

d. Instruments are divided into several classifications:

(1) Hand held, which consist of general use, microsurgical, and laser.

(2) Flexible and rigid endoscopes that require light carriers and fiberoptic cords, fiberoptic rigid telescopes used with bridges, sheaths, and obturators.

(3) Powered equipment which can be electrical, pneumatic, or battery operated.

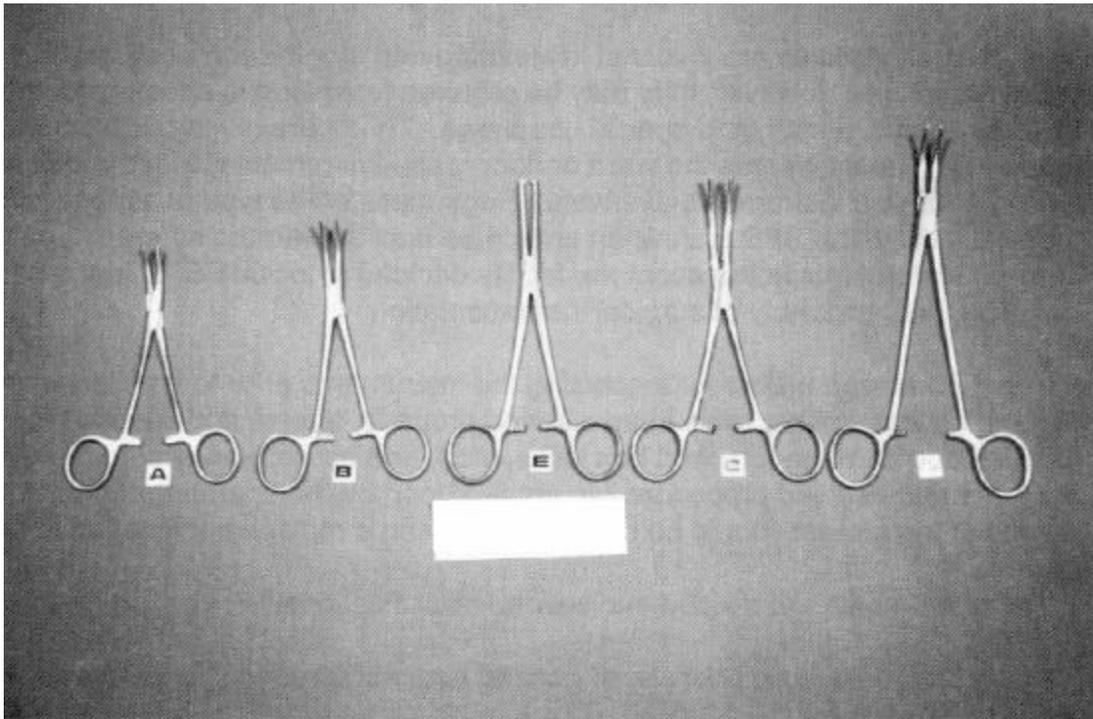
2. HAND HELD SURGICAL INSTRUMENTS

a. Hand held are the most common type of surgical instrumentation. Once the general, most common types of instruments are identified, the technician will be able to recognize them regardless of the different patterns, designs, and sizes utilized for specific surgeries. For example, tissue forceps used in eye surgery will resemble tissue forceps used in general surgery, the only difference being the size. The same holds

true for retractors, needle holders, etc. The exception to this would be the specialized instruments used for orthopedic and dental procedures.

b. The basic uses for these instruments fall into the following categories:

(1) **Hemostatic Forceps.** These forceps can be called clamps, artery forceps, and hemostats. The main purpose of hemostats is to achieve hemostasis (control of blood flow in the vessel). Most hemostats are available in different lengths, curved and straight, with serrated jaws. Some also have toothed ends. Examples of hemostats: Mosquito, Kelly, Carmalt, Schnidt tonsil, and Kocher.

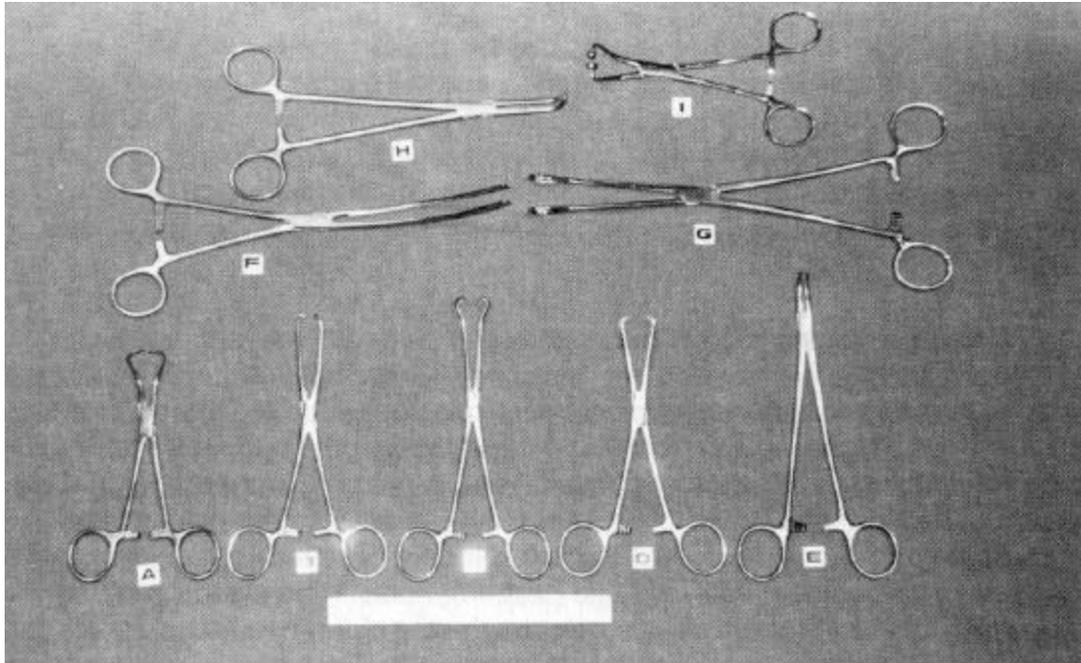


Hemostatic Forceps

(A) Mosquite, (B) Kelly, (C) Kocher, (D) Carmalt, (E) Schnidt Tonsil

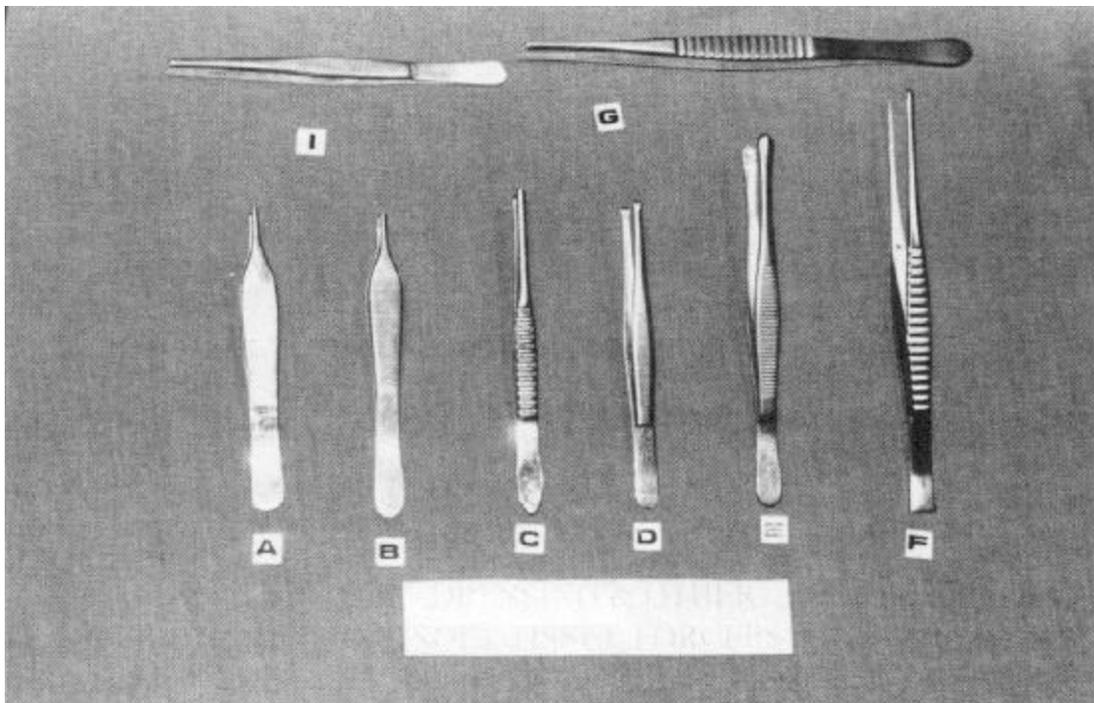
(2) **Soft Tissue Forceps.** Similar to hemostats, these forceps are used for holding and retracting soft tissue for longer periods. Characteristics include fine teeth or ridges on the jaws to provide a more delicate grip without trauma to tissue. They also consist of ring handles and box locks, as do the hemostatic forceps. Examples are: Backhaus Towel, Allis Intestinal, Babcock Intestinal, Kocher Artery, Mixer Gall Duct, Kantorwitz Right Angle, and Forester sponge forceps.

(3) **Other Soft Tissue Forceps (Thumb).** Thumb forceps do not have box locks or ring handles but rather have spring handles which are held closed by the



Soft Tissue Forceps

(A) Backhaus Towel, (B) Allis Intestinal, (C) Babcock Intestinal, (D) Lahey Goiter, (E) Mixer Gall Duct, (F) Doyen Intestinal, (G) Forrester Sponge, (H) Kantorwitz Right Angle, and (I) Nonperforating Towel Clamp



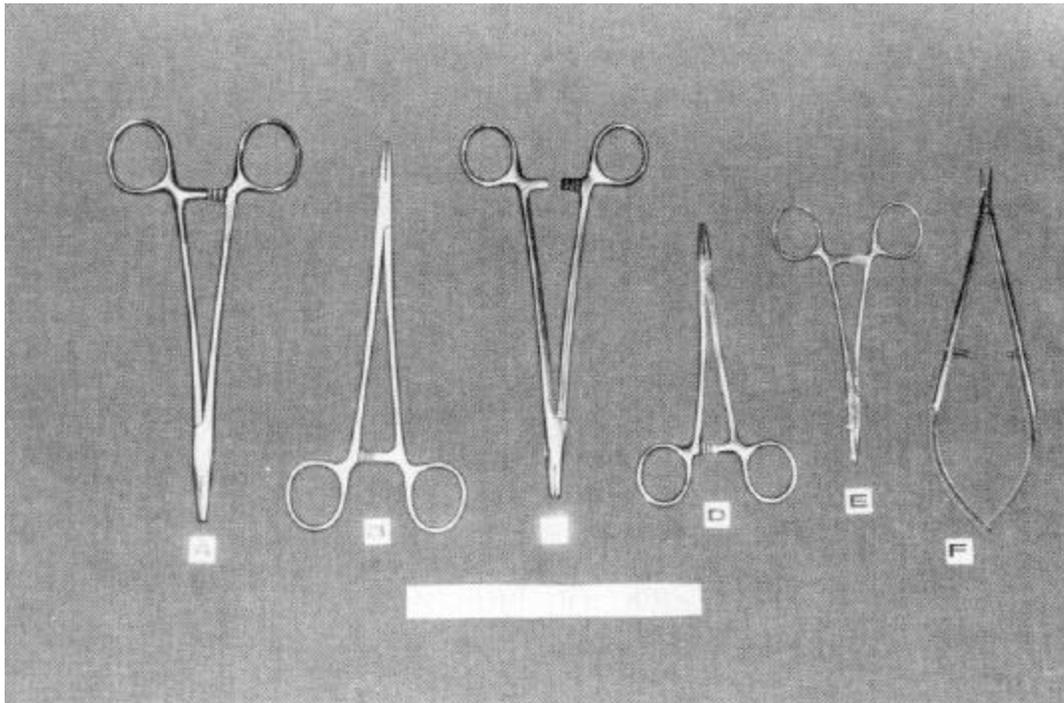
Thumb Forceps

(A) Adson, (B) Brown-Adson, (C) Thumb w/teeth, (D) Bonnie, (E) Russian, (F) Cushing, (G) DeBakey, and (I) Dressing

thumb and finger pressure. Sometimes this type of forceps is referred to as dressing forceps when the jaws are serrated and the instrument is used to grasp delicate tissue or wound dressing. A heavier version of this type of forceps is referred to as thumb tissue forceps used for grasping heavier tissue where the teeth will provide a more secure grasp. Examples of thumb forceps: Adson, Brown-Adson, Hudson, Dressing, Tissue Forceps with Teeth, Russian, Cushing, and DeBakey.

(4) **Needle Holders.** Sometimes referred to as needle drivers, this type of instrument is mainly ring handled, similar to hemostats but with smaller jaws which are shorter and thicker. Needle holders hold needles which are attached to sutures. These instruments are also available in a variety of lengths and styles and may be curved or straight. Needle holders have inserts in the jaw to prevent excessive wear of the instrument. These inserts are mainly made from tungsten carbide granules in a cobalt or other metallic paste. Needle holders with tungsten carbide inserts are normally identified with gold plated handles. The inserts can be replaced as they wear down, which prolongs the life of the needle holder and defrays the replacement cost of an entire instrument. Examples of needle holders: Mayo-Hegar, Crile-wood, Olsen-Hegar, Collier, and Webster.

Needle holders can also have spring handles which allow the user maximum results with minimum rotation of the wrist and hand. Most spring handled needle



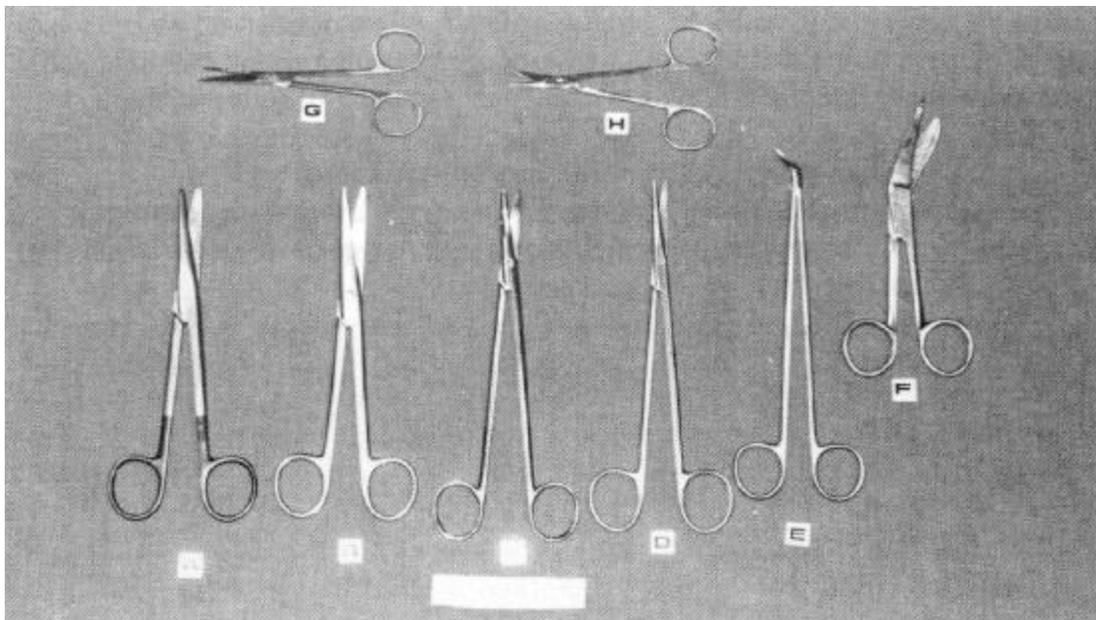
Needle Holders

(A) Mayo-Hegar, (B) Crile-Wood, (C) Olsen-Hegar, (D) Collier, (E) Webster, and (F) Castroviejo

holders will have a lock or catch to secure the needle and are used in surgical procedures requiring delicate suturing in tight or poorly exposed areas. Spring handled needle holders may also contain replaceable inserts. An example of a spring handled needle holder is a Castroviejo, 7 or 9 inch.

(5) **Scissors.** A large variety of scissors are utilized in the surgical suite to include many lengths, styles, curved, straight, sharp, and blunt. In general, curved scissors are used to cut and dissect tissue, while straight scissors are used for cutting sutures and any tissue when a smooth, straight cut is desired, such as a damaged nerve or blood vessel. Scissors can be used for probing, dissecting, and spreading tissue. These scissors should never be used to cut paper or tubing. Bandage scissors may be utilized for this purpose.

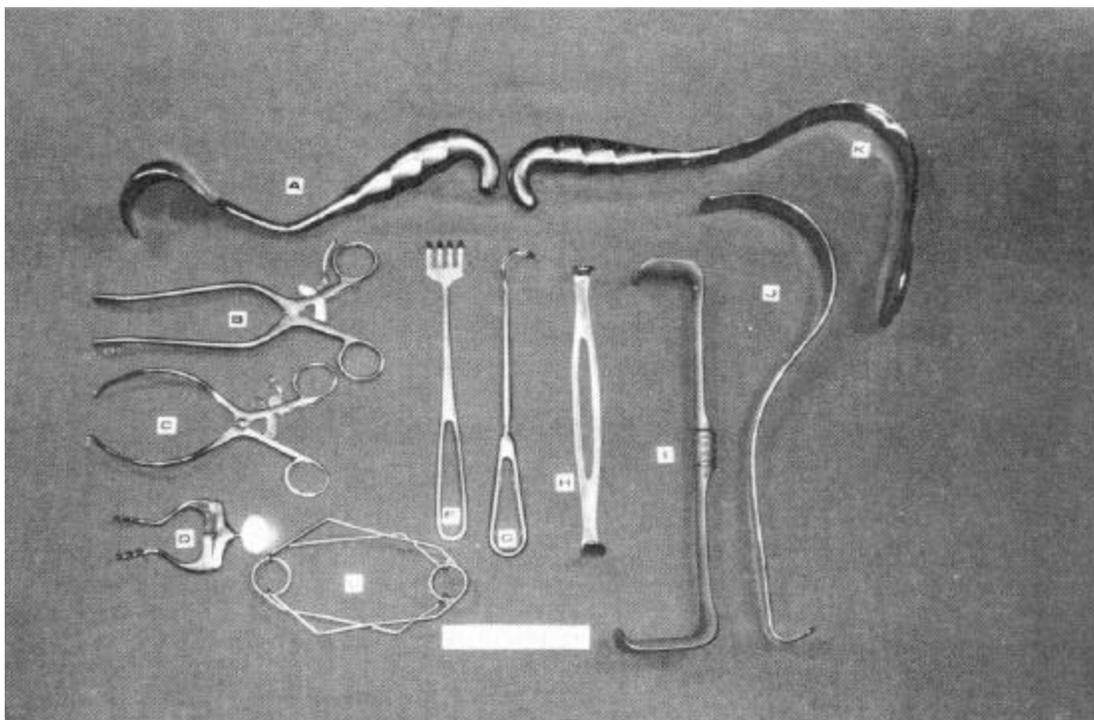
Major types of scissors include Mayo scissors, identified by heavy curved or straight blades with rounded tips; Metzenbaum (Metz) scissors, similar to Mayo only lighter in pattern and more delicate; Iris (dissecting) scissors, resembling cuticle scissors but more delicate in style. Operating or general use scissors can be used for cutting sutures and gauze. The heavier types are used for cutting fine wire sutures and are identified by angular blades with serrated edges with a groove for holding the wire as it is being cut. Scissors may also have tungsten carbide cutting edges which provide finer cutting with longer lasting wear. Scissors with tungsten carbide inserts are identified by gold plated ring handles.



Scissors

(A) Mayo Dissecting Straight, (B) Mayo Dissecting Curved, (C) Metzenbaum, (D) Metzenbaum Delicate, (E) Potts-Smith, (F) Lister Bandage, (G) Iris Straight, and (H) Stevens Tenotomy

(6) **Retractors.** Many varieties and sizes of retractors are available, and the use of specific retractors will largely depend on the type of surgical procedure being performed. Retractors are used for holding the incision open to provide exposure to the surgical site. Smaller types held by the fingers or hand retract skin and subcutaneous tissue in shallow surgical areas. Larger, heavier models retract muscle tissue and organs in deeper surgical sites. Some retractors are held in place by an assistant while the surgeon completes the procedure, while self-retaining retractors require no assistant to hold them. Self-retaining retractors are held open by their own action and may be used in conjunction with the hand held retractors. Examples of retractors: Richardson-Eastman, Mayo, Jansen Mastoid, Weitlaner, Cerebellum, Gelpi, Volkman Rake, Green Goiter, Army-Navy, Deaver.



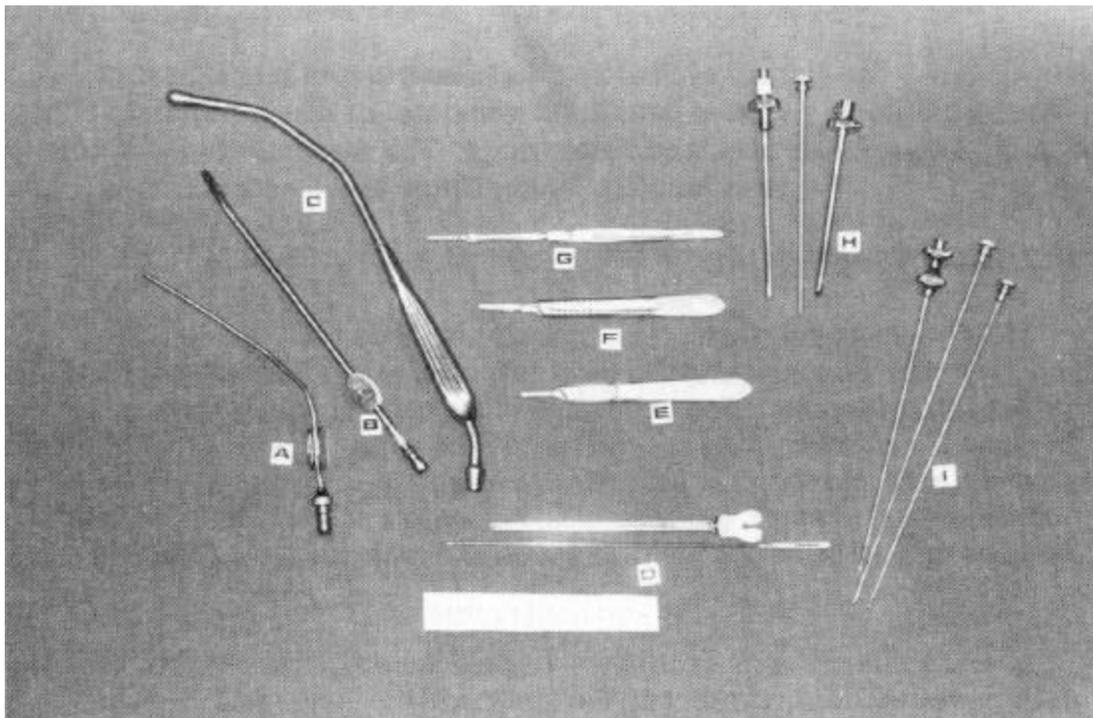
Retractors

(A) Mayo, (B) Cerebellum, (C) Gelpi, (D) Janson Mastoid, (E) Spring Wire, (F) Volkman Rake-Sharp, (G) Green Goiter, (H) Army-Navy, (I) Richardson-Eastman, (J) Deaver, and (K) Sweetheart

(7) **Miscellaneous.** Probes, biopsy needles, and suction tubes are a few of the miscellaneous instruments required for use in surgery or some clinical procedures. Probes may be used to explore the depth and direction of body ducts, sinuses, or cavities. They may also be used as an aid in dilating or irrigating an area of the body, such as a duct. Knife handles are available in several styles and require disposable blades that may be changed frequently during the surgical procedure. Example of probes and knife handles are probe with eye, optical probes, and knife handles number 7, 4, and 3.

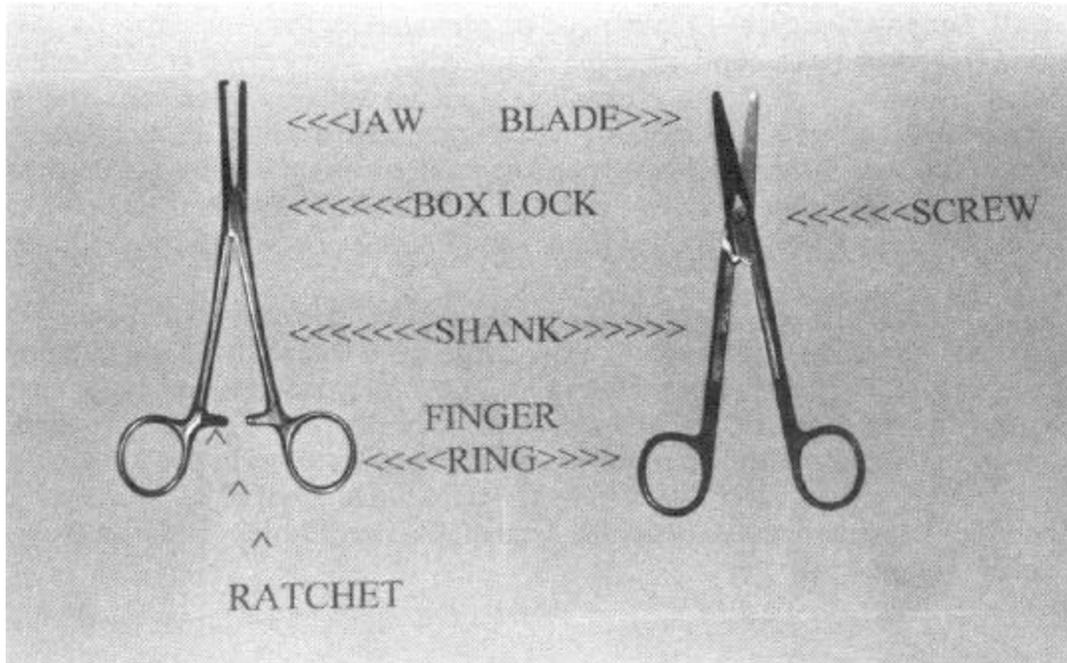
(8) **Biopsy Needles.** Biopsy needles are used for the removal of fluids or tissue for the purpose of microscopic examination. Many sizes and varieties of biopsy needles are available in stainless steel, as well as disposable varieties. Disposable needles do not require sharpening and inspection as do reusable biopsy needles. Reusable biopsy needles must be sharp and free of burrs to assure proper function and avoid damage and trauma to tissue. Examples of biopsy needles: Abrams Pleural Biopsy Punch and Franklin-Silverman Biopsy Needle.

(9) **Suction Tubes.** Suction tubes are used for the removal of blood, tissue, and fluids from the surgical site to allow surgeons a clear view of the anatomical structures during the operative procedure. Several types of tubes can be used, depending on the procedure, and many will have removable tips that require close attention during the cleaning process. The tube is attached to suction tubing connected to a graduated reservoir to measure the amount of fluid removal. Examples of suction tubes: Pool Abdominal, Frazier, Rhoton, and Yankauer Suction Tubes.



Miscellaneous Instruments

- (A) Frazier Suction, (B) Rhoton Suction, (C) Yankauer, (D) Probe w/eye and Groove Director, (E) No. 3 Knife Handle, (F) No. 4 Knife Handle, (G) No. 7 Knife Handle, (H) Abrams Needle, and (I) Vim Silverman Needle



"Anatomy" of the Hand-held Instrument and Scissors

The structure of a typical hand-held hemostat or clamp consists of jaws, box lock, shanks, ratchets, and finger rings. The surgical scissors consists of jaws, shanks, finger rings, and a screw.

3. ANATOMY AND QUALITY OF SURGICAL INSTRUMENTATION

a. The majority of surgical instruments are made from stainless steel which will vary in grade. Stainless steel, in most respects, is an ideal material that resists rusts, nicks, maintains a fine point, and, in the case of scissors, retains a keen edge for cutting. However, many are misled by the name "stainless," since stainless steel can spot and stain. In actuality, stainless is a "misnomer." There really is no "stainless" type of steel. Many surgical instrument companies "passivate" instruments prior to selling them, to assure the least amount of staining and spotting.

b. Passivation is a process which helps ensure an uninterrupted protective layer of chromium oxides is present on the surface of the instrument. This protective layer helps prevent against corrosion, spotting, and staining. Passivation occurs by exposing an instrument to the atmosphere or certain other oxidizing agents which results in a thin, protective surface or film. The chromium oxides are actually strengthened by repeated exposure to the oxidizing conditions that exist when washing and reprocessing instruments occur. Repeated instrument processing actually passivates it further, which explains why older instruments tend to stain and spot less than the new ones.

c. Other metals used in the construction of some surgical instruments are titanium alloy, copper, and brass. Some instruments are electroplated which means the instrument has a highly polished finish and often is easier to keep shiny. The disadvantage to this type of finish is the electroplating process can leave holes in the finish, resulting in potential rust and deterioration of the plating. Once the plating starts to deteriorate, the instrument should no longer be used for two reasons: the plating can chip off into the surgical wound site and cause infection and, once the plating is chipped, sterilization of the instrument cannot be accomplished.

d. There are four basic types of instrument finishes available. Shiny or mirror finish, which tends to reflect light and can restrict the vision of the surgeon. This finish does not spot and discolor as easily as other finishes. Satin or patina finish and the dull or matte finish reduce the glare at the wound site but tend to stain and spot more frequently. The matte finish is attained by a sandblasting technique utilizing glass beads or silicone. The fourth finish is an ebonizing type and is achieved by placing the instruments in a chemical bath. It is a nonglare finish primarily used for laser surgery. This finish is a black, microscopically irregular surface which scatters and absorbs laser energy. It keeps the energy from bouncing onto tissue surrounding the intended target and damaging the healthy tissue.

e. Instruments are available in two grades. The common instruments, hemostats, scissors, and soft tissue, are available in a "floor grade" metal. These instruments are made from forgings of lower grade quality metals and are usually plated. They usually bend or break easily, and the precision of key features is less exact than the higher quality O.R. grade instruments. Plated instruments can be scratched or chipped relatively easily and rust much easier than the higher quality instruments. They must be replaced more frequently. O.R. grade instruments are made from 300-4 grade stainless surgical steel and are more resistant to corrosion and wear. It is vital that the lower grade instrumentation be processed separately from the O.R. grade instruments. Rust, like cancer, can spread if these instruments are mixed. It is vitally important to protect the resources invested in surgical instrumentation.

4. CARE AND HANDLING

a. Care of the surgical instrument begins in surgery during their use. The instruments should be rinsed or wiped periodically to prevent blood and body fluids from drying. Avoid bouncing, dropping, and placing large, heavy instruments on top of delicate ones. The weight of a mass of instruments or entanglement in a haphazard heap can cause damage. Instrument counts are vital for patient care, as well as preventing loss by accidentally throwing them into the trash with the disposable drapes or sending them to the laundry with the surgical linens.

b. Blood and saline are the most common causes for deterioration of stainless steel. Exposure to these two elements will result in corrosion and ultimately pitting. Other chemicals to avoid are:

Aluminum chloride	Barium chloride	Calcium chloride
Blood	Carbolic Acid	Chlorinated lime
Dakin's solution	Ferrous choride	Mercury bichloride
Phenol	Mercury salts	Potassium thiocyanate
Ferrous chloride	Hydrochloric acid	Iodine

c. After surgery, string instruments not used during the procedure should be re-strung on their instrument stringer and placed back into the tray with any retractors or miscellaneous instruments not used. The instruments used during the procedure should be rinsed in water and any gross soil removed. Whenever possible, the soiled instruments should be placed in a soaking solution containing an enzymatic agent, and all instruments placed in covered containers and back into the case cart (an enclosed metal cart) for transportation to SPD. In the event your facility does not utilize a case cart system, the instruments should be placed into covered containers and picked up utilizing a closed/covered cart system.

5. RECOMMENDED PROCESSING PROCEDURE

a. Reprocessing of surgical instruments involves several steps:

- (1) Safe transport to the decontamination area.
- (2) Cleaning, safe handling, and decontamination.

b. Safe transport after use is designed to prevent contamination of personnel and the environment. Instruments and items should be placed in covered containers and/or impervious bags for transport to the decontamination area. Personal protective equipment is required of all decontamination personnel, and these requirements must be followed to prevent exposure to the technician, regardless of the types of items received into the area.

c. All instruments set up in the operating room will require reprocessing, regardless of their use during the procedure. Instrument sets opened and not used still require processing through an ultrasonic washer/sterilizer or washer/decontaminator. Inspect the instruments for tissue or bone remaining in the teeth or grooves. Remove this debris by holding the instrument under the surface of the water and scrubbing the area with an instrument brush.

d. During the cleaning process, always remember to open all instruments. For example, scissors should be opened, instruments with box locks should not be in a locked position, and multipiece retractors, staplers, etc., should be disassembled prior

to cleaning, as well as the required decontamination apparel required and mentioned in the Decontamination Chapter. This allows for all areas to be exposed to the cleaning process. Attention to all cannulated items or items with lumens, such as suction tubes, needles, and some orthopedic instruments is vital. These areas may harbor blood and body tissue. Brushes are available from manufacturers in many sizes, allowing access to the cannulated areas, and should be used faithfully to assure any and all debris is removed.

e. During the initial cleaning and throughout the subsequent steps, instruments should be handled in such a manner as to avoid damage to the instrument and to prevent injury to the technician. Heavy rubber or plastic gloves should be worn, as well as the required decontamination apparel required and mentioned in the Decontamination Chapter. This includes face shields or goggles, gloves, plastic apron, hair cover, and rubber shoe covers. Instruments should be handled in small groups to avoid tangling and damage. Needles should be separated and processed separately. The technician should watch for scalpel blades still attached to knife handles, and these should be removed and disposed of in sharps containers. All scalpel blades, disposable needles, saw blades, and drill points used during a surgical procedure should be disposed of by the operating room staff but may be inadvertently overlooked. Many instruments contain sharp edges and parts, and extreme care should be taken by the technician while handling any sharp item.

f. Only nonabrasive cleansers should be used for instrument cleaning, as the abrasive cleaners can damage the surface of the instrument, resulting in corrosion and rust. Instruments should be exposed to detergents that maintain a pH between 6 and 8. A neutral pH of 7 is ideal since a pH level too high (alkaline) or too low (acidic) will damage the surface of the instrument. Once this process is complete, rinse the instruments, then place them in the ultrasonic.

g. If the gross soil has been removed properly, the ultrasonic should remove the remaining soil. Gross soil is defined as excessive blood or body tissue that would impair the use of the instrument. Visual blood or body tissue is not necessarily defined as gross soil. The ultrasonic will penetrate into the box locks, joints, and screw areas of the instrumentation. The cleaning solution utilized by the ultrasonic should be changed frequently, as mentioned in the Decontamination Chapter. Instruments should be placed loosely in the ultrasonic, in metal baskets. Avoid plastic and rubber in the ultrasonic cleaner as they will absorb the sonic energy and the process of cavitation will not take place. After removing them from the ultrasonic, visually inspect the instruments for cleanliness. Instruments should then be rinsed and processed through the washer/sterilizer. Items that cannot be processed through the washer/sterilizer should be rinsed and placed in the drying chamber of the ultrasonic. If a drying chamber is not included on existing equipment, the instruments should be air dried or patted dry with an absorbent material so that no water is left standing on the instruments.

h. Microsurgical and delicate eye instruments should not be processed through a washer/sterilizer because the turbulent action of steam mixed with water may damage them. Once these delicate instruments are processed through the ultrasonic, rinsed, and dried, they should be processed on a sterilize cycle only to assure a decreased bioburden is achieved to allow safe assembly by the preparation room instrument technician.

i. Washer/sterilizers are the next step in the cleaning process. Stainless steel instruments should not be processed close to instruments made of metals, such as nonanodized aluminums, brass, copper, or chrome plating. A reaction known as electrolysis may occur, resulting in metal plating onto another. This reaction can result in permanent damage and staining. Ideally, demineralized or deionized water should be used in the washer/sterilizer to prevent mineral buildup and chemical reactions associated with regular tap water. A drying cycle should be set to assure the instruments will dry completely and not emerge wet after the cycle. If the instruments do not dry completely, steps should be taken to dry the instruments. Utilizing an air hose to blow excessive moisture from the instruments or manually drying with absorbent material are two recommendations.

j. Newer washer/sterilizers consist of a lubrication cycle that exposes instruments to a lubricant that helps prevent stiff and hard working joints, box locks, and assures smooth action of multifaceted items such as rongeurs, retractors, and stapling devices. Most facilities do not have the newest available processing equipment, and lubrication of instruments must be accomplished in the preparation area, prior to sterilization.

k. Controversy still exists concerning the order of processing instruments. Some institutions recommend processing the instruments through the washer/sterilizer first to protect the technician working with the contaminated items. Washer/sterilizers may not remove all of the soil and will bake any remaining debris onto the instrument, which makes it more difficult to remove. The ultrasonic will not be able to remove baked on debris and would require the technician to manually clean all instruments. A reminder -- proper attire and safe handling are the keys to proper processing of instruments and still allow protection for the decontamination room technician.

l. Telescopes, fiberoptic cords, and power equipment will require manual cleaning and disinfecting and cannot be processed in the same manner as the general hand held instrumentation.

6. PREPARATION AND STERILIZATION

a. Recommended steps to follow in the preparation area:

(1) Inspection for cleanliness and proper function.

- (2) Separating instruments that require repair or replacement.
- (3) Set or tray assembly and single instrument packaging.
- (4) Preparation for sterilization.
- (5) Sterilization and sterile storage.
- (6) Transport to point of use.

b. Once the instruments have been received into the preparation area, a thorough inspection for cleanliness and proper function must be done while assembling the instrument tray or prior to storage. Depending on the facility, instruments are either assembled into sets or trays, or stored until the next surgical schedule is received. Once the schedule is posted, instrument sets will be assembled for those particular cases and the process is repeated. It is ideal to have the sets pre-assembled in case of emergency surgery or add-on cases.

c. If any instrument is received into the preparation area with visible evidence of soil, it should be returned to decontamination for reprocessing. Never clean an instrument in the clean preparation environment. Proper instrument function and condition should also be assured. To check a needle holder, place it in the locked position and hold it up to the light. Visible wear is apparent when a gap is noted between the tungsten carbide inserts and should be replaced. Another method would be to place an appropriate size suture needle into the jaws, closing the ratchets to the second position and attempting to turn the needle with the fingers. If the needle turns, the inserts are worn and should be replaced. Extreme care should be taken to avoid injury.

d. Other items to look for will include checking for nicks, rust, corrosion, burrs, pitting, and cracks in the box lock. Certain instruments should be checked for proper jaw alignment, freely moving box locks, loose screws, and freely moving hinges on scissors or other multijointed instruments. The proper tension is required with scissors to allow cutting surfaces of scissors to meet properly. Test instruments with box locks and ratchets to assure proper tension. The tips of instruments with jaws should just meet before the ratchet is engaged. As the jaws engage, the entire length of the jaw should mesh. The instrument should be tested by locking the ratchet into the notch and gently tapping it against the palm of your hand, or gently against a counter edge. If the ratchet disengages or pops open, the instrument requires repair.

e. Scissors should be tested for sharpness by cutting a single layer of gauze. A sharp pair of scissors will cut cleanly through, all the way to the tips. Burrs may be noted on the tips of the scissors as you are cutting the gauze, even if the blades appear sharp. Paper should never be used to test scissors because it can dull the scissors and

is not a true test for sharpness. There are new products available for testing the cutting edge of scissors which resemble the texture of tissue.

f. A detailed instrument repair program should be established, and a reputable instrument repair company contracted with, to assure the instruments are repaired correctly and returned in a timely manner. Cost will be a major factor in the repair of surgical instrumentation and should be tracked. A designated area should be set aside for damaged instrumentation and the instruments should be repaired on a set schedule. It is vital that all malfunctioning instruments be repaired and not returned to an instrument set. An improperly functioning instrument could cause delays during the course of the surgery, or worse, cause harm to the patient.

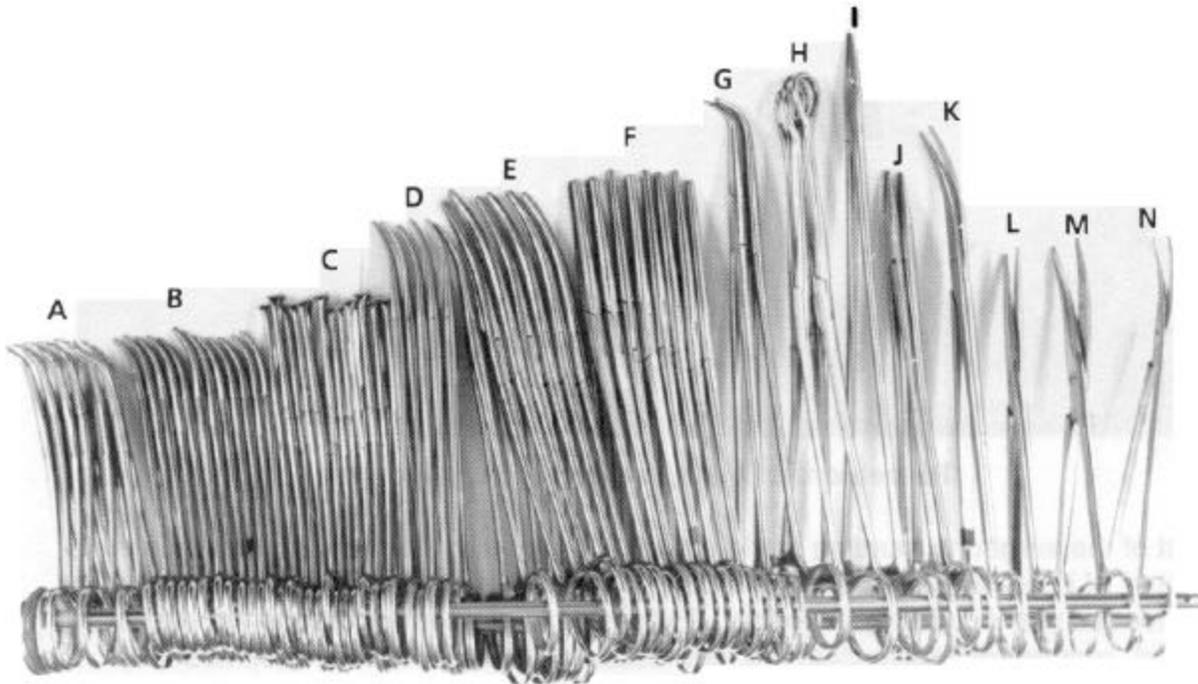
7. INSTRUMENT SET ASSEMBLY

a. Instrument trays should be assembled using a detailed photo procedure. Ring-handled instruments should be placed on a stringer, instrument rack, or other means that allows the instruments to remain in an open or unlocked position. This will allow the sterilant contact to all surfaces. Instruments with multi parts, such as a Balfour retractor or tonsil snare, should be disassembled to allow all parts exposure to the sterilant.

b. Instruments placed on a stringer or rack will require placement in such a manner to prevent damage to the instruments and easy, orderly access by the operating room scrub nurse. The illustration below shows the proper alignment of string instruments. The scissors can be turned in, toward the center of the stringer, as long as the tips do not touch another instrument. In many cases, the tips of the curved scissors will face away from the center of the stringer to prevent damage to the curved tips. The shorter instruments are at the end of the stringer, with the longer toward the center. This order aids the operating room nurse since the instruments at either end of the stringer will be used first during the procedure, with progression to the longer instruments as the case proceeds.

c. Knife handles, tissue forceps, pickups, probes, etc., may be wrapped in medical grade paper or placed in pockets to allow easy access to the items. **Note illustration.** Foam inserts can be purchased by the roll or individually. The foam may be cut to the desired length, depending on the number of instruments used. It is important to remember only medical grade paper or materials should be placed inside an instrument tray. Nonmedical grade paper will contain pulp and wood particles that can redeposit on instruments during a pre-vacuum sterilization cycle. Other items, such as gauze, cotton tipped applicators, etc., should be packaged separately from the instrument sets to allow proper exposure to the sterilant. Gauze is not recommended to be included in surgical instrument trays but, if it is, it must be included on the count sheet. Operating room nurses are required to do a sponge count, and any additional gauze placed in the tray or set may not be accounted for.

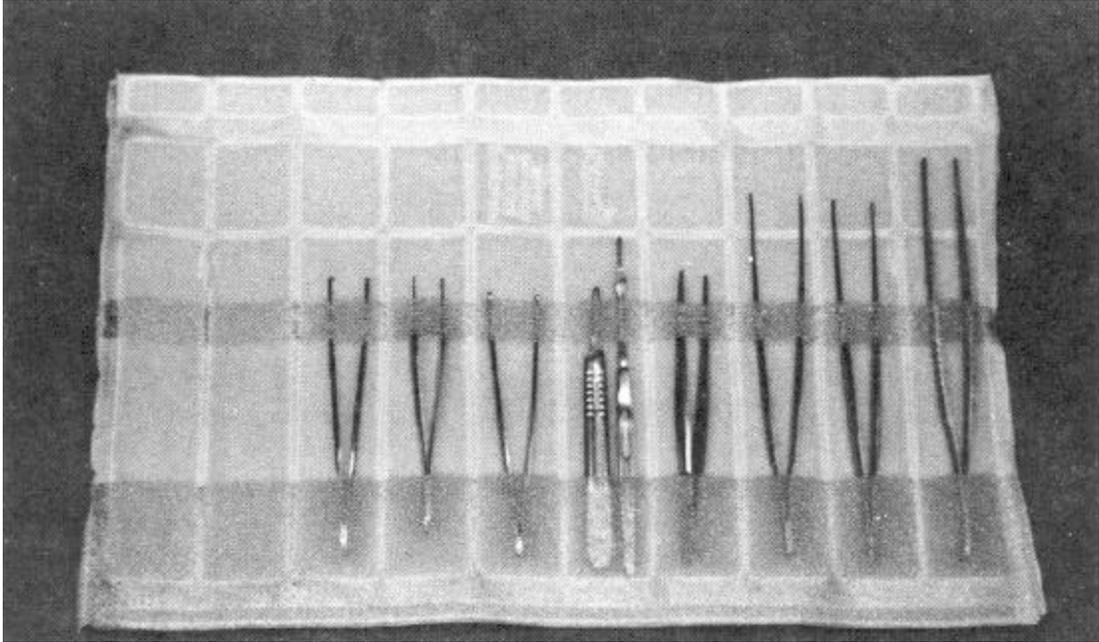
**PROPER ALIGNMENT
OF
STRING INSTRUMENTS**



(A) Backhaus Towel, (B) Kelly Forceps, (C) Allis Intestinal Clamps, (D) Crile Forceps, (E) Carmalt, (F) Kocher Clamps, (G) Right Angle Clamps, (H) Forrester Sponge, (I) DeBakey Needle Holder, (J) Mayo-Hegar Needle Holder, (K) Curved Metzenbaum Scissors, (L) Straight Mayo Scissors, (M) Curved Mayo Scissors, (N) Curved Metzenbaum

d. Instruments should be placed in a tray with a perforated bottom. The perforations should be small enough not to allow the instruments to protrude through. Many facilities utilize towels or absorbent disposable tray liners to prevent this. The tray liner may also be used to wick moisture away from the instruments and allow rapid drying during the sterilization dry cycle. Place the instruments in such a manner to allow contact to all surfaces during the sterilization cycle. Large heavy items, such as retractors, should be placed on the bottom of the tray. The stringed instruments should go in last, to assure no heavy item will be placed on top that may damage the delicate tips. See illustration for instrument placement.

e. Basic sets should be standardized and reviewed periodically. So-called basic sets have the tendency to grow to such an extent that personnel complain about the large number and kinds of instruments being processed but not used. Periodic review of basic instrument sets should be done on a routine basis, with the input of the

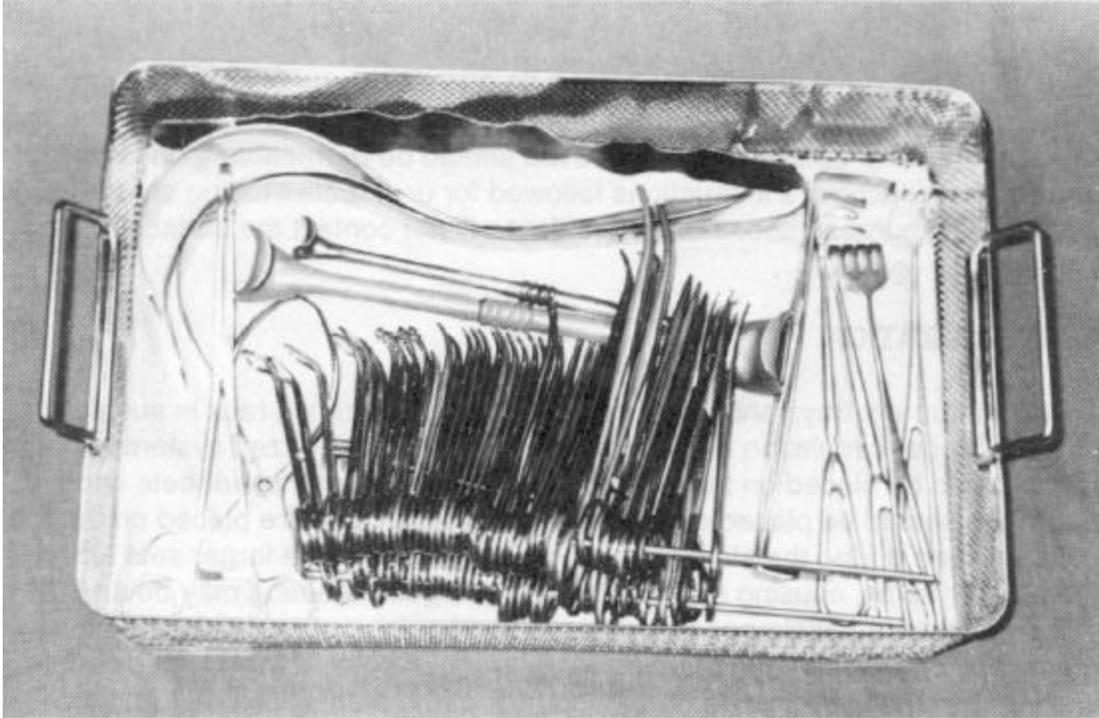


Placement of Instruments in Foam Inserts

surgeons, nursing staff, and SPD supervisor. It is vital to maintain the number of instruments in each set to allow the set to remain functional, yet not overloaded with unused instruments. Excessive instruments increase the weight of the set, require excessive cleaning, and assembly time. If the set becomes too large and the staff feel they require all the instruments, it is suggested breaking the set down into a regular basic set and a smaller supplement set. The instruments should be placed in a definite or fixed pattern within the tray to allow easy access to the instruments by the scrub nurse. Instrument sets may be placed on the sterile field contained in their tray and individual instruments removed as needed.

f. Recommended weight for an instrument set is 16 to 17 pounds, but the size of the tray used will determine how many instruments can be placed into a set and safely sterilized. Instruments should not be over crowded into a too small tray. This will prevent the proper exposure to the sterilizing agent. Placement and tray size are as vital, if not more important, than a weight limitation. Many specialized orthopedic trays will weigh in excess of 40 pounds, yet may be safely sterilized due to proper placement of items in the set. Containerized systems will increase the weight of the set but do not compromise sterility because of the weight increase. Good judgment in set assembly, tray size, and safety issues should be utilized when assembling any surgical instrument set.

g. Specific trays can be purchased for sterilization of micro surgical instruments and delicate ophthalmic (eye) instruments. These trays contain inserts that prevent movement and allow greater protection for these instruments.



Instrument Placement

h. Once the set is assembled, a content inventory list is added with the initials of the SPD technician who prepared the tray. This serves as a double check for the technician and may be used to enhance communication between SPD and the operating room staff, as well as providing a good quality improvement tool. The set is then wrapped with muslin or nonwoven disposable wrap, or placed into a container system, and placed on the sterilization rack in an upright manner. Never tip a surgical instrument set on its side. Tipping will cause displacement of the instruments and may damage them. This includes storage and transportation of the sterile set.

i. Individual instruments can be packaged in peel packs (paper/plastic pouches) or wrapped in muslin or nonwoven disposable wrap. When using peel packs, place the handle or holding end toward the opening end of the pack to assure aseptic presentation. Double peel packs or paper plastic pouches are required for items packaged for use in surgery. This means the instrument or item to be packaged should be placed in an appropriate sized pouch, sealed, then placed in the next larger size pouch. This will allow the circulating operating room nurse to open the first package and the scrub nurse to access the inner pouch without compromising the sterility of the operating field. Double wrapped muslin or nonwoven disposable wrap accomplishes the same effect. When using a wrapper, the outer wrap should be extended around the tray or item and never tucked. Wrappers and techniques will be discussed in the Packaging Chapter. Double peel packs may be preferred by some O.R.s for items packaged for use.

j. If the instrument has sharp points, tip guards can be utilized for protection of the instrument. Commercially available tip guards or foam sleeves can be purchased for this purpose. Tip guards or foam sleeves should be permeable to the sterilant used and the manufacturer's instructions followed for use. Latex tubing should never be used for this purpose because the sterilant will not contact the surface of the instrument.

8. STERILIZATION

a. Instrument trays should be placed on the sterilization rack in such a manner to allow proper circulation of the sterilant. Large containerized systems or surgical trays should be placed on the bottom rack, while smaller trays or sets and individual packages should be placed on the top rack. If large sets are placed on the top rack, condensation during the sterilization cycle may form on the larger sets and drip onto the smaller items, causing staining of the packages. Staining may be an indication of a contaminated package. Linen packs and basin or utensil sets should be processed separately from the surgical instrument sets. If this is not possible, the linen items should be placed on the top rack of the sterilization cart and the instruments sets on the bottom rack. Limit mixed loads as much as possible. Mixing muslin or linen items with instruments can cause staining of the surgical instruments.

b. The illustration shows a loaded sterilization cart. Note the wrapped basins and small tray are placed on the top shelf. Adequate space is allowed to provide good sterilant circulation to ensure proper drying at the end of the cycle.

c. Each item assembled and sterilized should be marked with the name of the set or name of the item individually wrapped and the initials of the technician assembling the item. If one technician assembles a set and another technician wraps the set, due to shift change and lack of time to complete the wrapping, then both initials should be noted in or on the package set. A quality assurance program should be implemented in order to verify that instrument sets are complete. An example would be a quality assurance monitor where instruments are double checked.

d. As mentioned earlier, several conditions can cause spotting and staining of surgical instruments. Steam provided to the sterilizer may contain minerals and rust deposits from the steam line. Steam line filters can aid in prevention of some of these deposits. All instruments and sets that have been opened but not used, or have outdated, will require reprocessing through decontamination due to spotting and staining, which may lead to malfunction of the instruments.



Placement of Trays for Sterilization

e. Another cause of staining can be attributed to the pH of the water and detergent used by the laundry. If surgical linens and muslin wraps are washed in a detergent high or low in pH and improperly rinsed, the residual soap may redeposit on the instruments during the sterilization cycle. It is recommended sterilizing surgical linen packs alone.

f. Other causes of stains:

STAIN

Rust colored - light or dark

CAUSE

Mineral deposits from tap water in final rinse.
Laundry improperly rinsed-detergent residue.

	Incorrect pH detergent utilized in the washer/sterilizer-decontaminator. Combining imperfect chrome instrument with stainless steel instruments.
Bluish-gray stain	Cold sterilizing solutions inadequately rinsed from instruments.
Purple-black stain	Ammonia in detergents. Amines from impure steam in lines.
Corrosion (rust)	Insufficient rinsing of instruments and/or linen during processing. Dried blood or residual soil in box locks. Prolonged exposure to harsh chemicals. Inferior grade instruments.
Pitting	Exposure to saline, potassium chloride, blood, or other components/compounds. Detergent residue or high pH. Metals with dissimilar composition processed together.

g. Cracked box locks are caused from blood and debris buildup which has the appearance of rust. The solution for this problem is thorough cleaning with ratchets open to prevent this buildup.

9. STORAGE AND TRANSPORTATION

a. Once the sets/packages are sterilized, a cooling time is required prior to dating and handling. Containerized systems may be labeled and moved prior to complete cooling, since the metal or anodized aluminum containers will provide protection and will not allow for strike through as a muslin or nonwoven wrap will. The technician should wait until the container is cool enough to handle, yet not cause injury because it is still warm. Wrapped sets must be entirely cool prior to dust covering and handling. If wrapped sets are handled prior to cooling, the sterile integrity of the package will be compromised.

b. A sterile storage area should be provided for all sterilized sets kept in SPD. The sets should be placed on the shelves in such a manner to avoid tearing of the dust cover or wrap. Containerized systems may be stacked as needed. Again, instrument sets should

never be tipped to avoid damage and disarray of the instruments contained within. If instrument sets must be stored in the operating room, they should be transported in clean, covered, or contained carts and handled with care and good judgment during transportation and storage.

10. ENDOSCOPIC EQUIPMENT

a. Endoscopic equipment may be rigid and/or flexible. This equipment is used to view the body organs, either through an orifice such as the mouth or anus, or through small puncture sites over joints or in the abdomen, for example. Endoscopic instruments are complex and may consist of several lenses carefully aligned along the instrument, one or more lumens, and may contain fiberoptic bundles. All endoscopy equipment require extreme care during use and cleaning. Detailed procedures and information for sterilization are required to prevent unnecessary damage to the equipment. Inservices should be provided to the technician to assure thorough knowledge is attained.

b. Rigid endoscopes include cystoscopes, resectoscopes, laparoscopes, arthroscopes, and hysteroscopes. Flexible scopes include gastrointestinal scopes, bronchoscopes (see illustration), sigmoidoscopes and colonoscopes. New and innovative designs are being introduced to the medical/surgical field as technology improves.

c. Rigid endoscopes may contain channels, ports, hinges, and stopcocks that must be cleaned and rinsed properly to remove debris, such as mucus, blood, and other body fluids. Rigid sheaths are used with telescopes, and they, too, contain channels and stopcocks. Close attention is required when cleaning these items. Air and water pistols can be utilized to dislodge debris from these areas, and protective attire is always required to prevent exposure to aerosols that might be produced. A neutral pH detergent should be used to prevent damage to sensitive parts. Some rigid endoscopes that do not contain lenses may be processed through the washer/sterilizer, such as a Jako Laryngoscope. Always follow the manufacturer's recommendations concerning proper cleaning and sterilization procedures. Telescopes used with rigid sheaths should be hand washed and dried. Never process a telescope through an ultrasonic or washer/sterilizer. Some sheaths and resectoscopes will not tolerate the ultrasonic due to the type of epoxy used to manufacture the sheath. For example, a Berry rotating sheath used for cystoscopies.

d. Care must be taken while cleaning the lens on rigid telescopes. Alcohol may cause the glass to appear scratched, if used repeatedly. Preventive care should include the following:

- (1) Do not boil or autoclave telescopes or resectoscopes.
- (2) Never bend, drop, or pile instruments on top of telescopes.

(3) Do not use ultrasonic cleaning which tends to loosen optical cement from the lens.

(4) Routinely lubricate stopcocks or moving parts with silicone lubricant.

(5) Use only nonabrasive metal polish on metal parts only.

e. Telescopes should also be checked for clear vision. If the field is not clear, the telescope should be washed, dried, and reinspected. Inspect the cover glass on the working end for cracks or chips. A half-moon but clear view could indicate a dent on the outside of the scope. If the view appears foggy, this denotes a leak somewhere on the telescope which has allowed moisture to enter. The shaft of the telescope and the light cord contain bundles of glass rods that conduct light to allow visualization of internal body parts. The telescope and light carrier are attached to a powerful light source which allows the light to travel through the glass bundles. Care must be taken not to bend the cords or light carriers in such a manner as to damage these glass bundles.

f. Light carriers or cords supplied today are manufactured to withstand steam sterilization. Always check the light carriers by holding one end to the light while viewing through the other. Look for any black areas or dots. Black dots denote areas where the fiberoptics are broken. Light carriers or cords in this condition should be repaired or replaced.

g. All rigid sheaths, telescopes, and any instrument containing lumens should be thoroughly dried prior to storage or ethylene oxide sterilization. If moisture is allowed to remain during storage, bacterial growth may occur. Moisture remaining during ethylene oxide sterilization can cause a chemical reaction that may harm the patient.

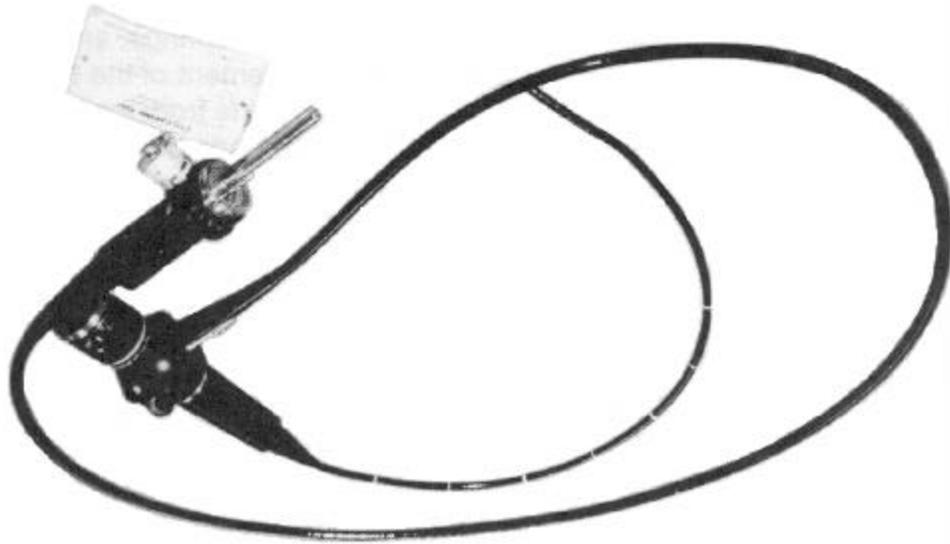
h. All rigid telescopes used in the operating room should be terminally sterilized prior to use. Disinfection produces a clean but nonsterile item. A new process recently introduced involves a liquid sterilizing agent called paracetic acid. A 30-minute processing time is required, and the telescope may then be introduced to a sterile field utilizing aseptic technique. Some telescope manufacturers claim their telescopes may be steam sterilized. It is important to recognize that the expansion during heating and contraction during cooling are completely different for metal and plastic. The difference in contraction and expansion may damage the plastic parts and will shorten the life of the instrument. To maintain the longest life expectancy from any rigid telescope, it is recommended that ethylene oxide be used for sterilization.

i. Regardless of how the telescope is processed, all completely metal components of endoscopic instruments can, and should, be steam sterilized. Telescopes and other items not designated for steam sterilization should be packaged separately.

j. Flexible endoscopes consist of fiberoptic glass bundles arranged around a lumen or lumens, a series of lenses and mirrors, coils, springs, and cables running the entire length of the instrument to control the movement of the tip. The covering is an impervious material that protects the working parts from moisture and other fluids (see illustration). The insertion tube length is marked so the surgeon knows how far the tube has been inserted into the body. The insertion tube is attached to the head or viewing lens of the flexible scope. An attachment can be added to the head of the flexible scope that has a flexible viewing cable with a lens attached, so someone assisting with the procedure may view what the surgeon is seeing. Attached to the head of the scope is another cable containing fiber bundles called the universal cord. This cord is inserted into the light source to enable light to be transmitted through the insertion tube which allows enough light to illuminate inside the body. Included in the head of the scope is a knob which allows the surgeon to turn and move the distal tip of the insertion tube. This enables complete viewing of the area.

k. Some flexible endoscopes will have a biopsy, air, and water channel. The biopsy channel allows insertion of flexible biopsy forceps, grasping forceps, and snares to obtain a biopsy or remove polyps. The air and water channels allow irrigation and air insertion to better visualize the area. Immediately following the procedure, these ports and channels should be flushed, brushed, and rinsed to prevent any debris from drying. The flexible scope can then be processed on an endoscopic processor which cleans and disinfects the scope. Many endoscopic processors will also provide a drying cycle. If terminal sterilization is indicated, an air hose with a pistol end should be used to assure no moisture has been left in any port or channel. If indicated, the EtO cap should be placed on the designated area of the scope to assure equal pressure and sterilant contact during the sterilization cycle. Newer endoscopes may contain a tiny camera or micro-chip to allow photos during the procedure. Also, newer versions may not require the EtO cap. Always check the manufacturer's information prior to processing any scope. Detailed and current procedures should be maintained in the decontamination and preparation areas of SPD.

l. Hospitals vary in the requirements for sterilization and disinfectant levels used for reprocessing scopes. The procedures utilizing scopes will normally determine the type of processing required. This, along with input from infection control, will normally determine the level of disinfection or sterilization. All reprocessing should be accomplished within SPD, regardless of the point of use. Clinics, the operating room, and the Chief, SPD, should work out methods of transportation, time schedules, and cleaning procedures to assure adequate support to the services for the cleaning, care, and handling of all endoscopes.



Flexible Endoscope with EtO Cap Attached

m. Accessories used with these flexible scopes consist of long, small wire springs, and adequate cleaning is difficult to achieve. Submersion in a blood and protein dissolving solution is recommended, followed by processing in the ultrasonic and washer/sterilizer. These items, once thoroughly dried, may either be placed in the tray with the flexible endoscope for ethylene oxide sterilization or packaged separately and steam sterilized. Many facilities have switched to the costly disposable accessories due to the difficulty cleaning the reusable ones.

11. POWERED EQUIPMENT

a. Power equipment utilized by surgery includes a wide variety utilizing different power sources. Power sources may be electrical, either line current or battery, compressed medical gasses, such as carbon dioxide, nitrogen, or compressed air. Equipment powered by gasses are referred to as pneumatic or air-powered instruments. Examples of power equipment are: reamers, drills, screwdrivers, and saws used by orthopedic and some neurosurgeons. Craniotomes, drills, and perforators are used by neurosurgeons. Dermatomes are used by plastic and general surgeons to take skin grafts, and sternal saws are used by thoracic surgeons to cut the sternum.

b. Powered equipment should be cleaned and cared for according to the manufacturer's recommendations, but under no circumstances should a power instrument be immersed in a solution of any kind. They should never be processed through an ultrasonic or washer/sterilizer. The attachments used with the equipment, however, may be processed in the same manner as most stainless steel surgical instruments. These attachments can include chucks, chuck keys, burr guards, hudson and trinkle adapters, and wrenches. These attachments are all metal and will retain a great deal of blood and debris. Close attention should be give to ensure the power equipment and attachments are thoroughly inspected and cleaned. All attachments must be removed from the equipment before processing. Saw blades, drill points, and bits should be discarded in the operating room after the surgical procedures. These items should not be reused because the sharp cutting edge cannot be guaranteed once they have been used.

c. Skull perforators should be checked frequently and sent for sharpening on a routine basis. Due to their cost and complexity, a maintenance schedule should be established. Disposable, single use perforators are being produced by several vendors but the cost still remains high. Air hoses should be inspected prior to cleaning for any damage, then washed with a mild detergent and lukewarm water. Never immerse the cord into any solution. If the equipment has an electrical cord, the cord may be washed with a cloth soaked with mild detergent solution. Other components are also cleaned in this manner, then wiped with a disinfectant to assure safe handling prior to packaging.

d. Newer powered equipment requires no lubrication since they are self-lubricating and are enclosed with a sealed casing. Older equipment will require some lubrication, and this should be done during the testing process. Pneumatic equipment should be hooked up to compressed air and tested within the required PSI (pounds per square inch), and the pressure never exceeded to prevent damage to the equipment. Battery operated power equipment may be tested also with a battery pack. If compressed air is not provided with a wall gauge and a tank is required to be stored in SPD, measures must be taken to secure the tank safely to the wall. A battery pack may also be purchased and kept in SPD to test the battery operated equipment. Any equipment that does not function correctly should be sent for repair. If backup equipment is not available, a loaner piece will be required to assure surgery cases are not canceled. Any time equipment malfunctions the operating room should be notified.

e. Sterilization by a prevacuum sterilizer is recommended most frequently for a large majority of equipment. If gravity displacement sterilizers are used, the sterilization time must be lengthened. Electrical equipment should be sterilized by ethylene oxide to prevent damage to the electrical parts. With the variety and complexity of power equipment available, it is recommended that detailed cleaning, testing, and assembly procedures be provided for the technician's use. Frequent inservices will keep the SPD staff abreast of current changes and technology. Remember, always follow the manufacturer's recommendations.

12. NEW TECHNOLOGY

a. As surgical procedures and techniques change, so do the types of surgical instrumentation and implants. For example, orthopedic implants are being developed and improved upon at such a rate that it is difficult for medical centers to keep pace with the instrumentation required to perform these implants. Because of this, many companies loan the instrumentation to the medical centers. It is more cost-efficient for both parties.

b. Because of the number of new implants, each medical center SPD should develop a procedure to handle the instruments being brought into the medical centers. It is recommended that the instrumentation being loaned be brought directly to SPD with a detailed list of every item in the set. The sales representative and the SPD supervisor or technician should review the list against the instrument set. If any item is not in the set, it should be noted.

c. The instrument set should then be processed through decontamination, assembled, and wrapped for terminal sterilization. The name of the set, operating room number, case number, and, preferably, the patient's name, should be listed on the instrument set. After sterilization, this set should be placed on the case cart prior to the case. In the event your medical center does not utilize a case cart system, the instrument set should be delivered to the operating room.

d. After surgery, the loaner instrument sets must be returned to decontamination, processed, and reassembled. The company's sales representative should pick up the loaner instrument set from SPD.

e. Prior to leaving the medical center, the SPD supervisor or technician should again check the set against the list to assure all parts have been accounted for. In the event a piece is missing, the sales representative or SPD personnel will check with the surgical suite or with SPD to attempt to locate the part.

f. By using a check list, SPD will not be inadvertently charged for an instrument or part that was not present when the set was sent to the medical center. In some cases, instrument sets are shipped to a medical center without the sales representative being present. Insist that the company send a list with the loaner sets. In the event an instrument set contains implantable pieces, the sets should be received by SPD at least 48 hours prior to the scheduled case to assure the quarantine time is achieved.

g. To maintain a loaner program, cooperation between the operating room and SPD is vital. Details should be worked out between the two areas, and all companies that supply loaner instrument sets should be notified of the program. This system is extremely important since SPD is responsible for all items sterilized. Instrument sets brought into the medical center may not be clean, and there should be no doubt about

the cleanliness of an item prior to sterilization. All items leaving the medical center should be thoroughly cleaned to prevent any cross- contamination.

h. Each medical center should develop a comprehensive system of tracking all loaner instrumentation and implants utilized by the operating room.

13. **SUMMARY.** Surgical instruments, flexible and rigid scopes, and powered equipment come in many varieties, complexities, and include numerous pieces, parts, and attachments. A good working relationship between the operating room staff and the SPD staff is vital to provide the information, service, and continued support to assure safe patient care. The SPD technicians should routinely observe surgery to understand the necessity of accurate tray and set assembly and proper function of all equipment. Training programs can be established by SPD to aid in the training of new operating room nurses, nursing students, and SPD technicians in instrument identification and set assembly. With technology and innovative instrumentation always changing, we must continue to sharpen our skills and knowledge.

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SURGICAL INSTRUMENTATION TERMS

Box Lock
Blade
Ebonize
Electroplate
Endoscope
Finger Ring
Forceps
Hand Held
Hemostat
Jaw
Matte
Passivation
Pneumatic
Power Equipment
PSI
Ratchet
Retractor
Satin
Shank
Tissue Forceps

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QUESTIONS

TRUE/FALSE

1. All powered equipment utilized in the surgical suite today requires EtO sterilization due to the complexity of the equipment.
2. It is not necessary to check light cords for adequate light transmission or broken fiber bundles.
3. All hand-held surgical instrumentation must be checked for cleanliness and proper function.
4. Instrument trays opened in the surgical suite, but not used, are still required to be reprocessed through decontamination.
5. Cracked box locks will not affect the function of the instrument and can be used without repair.

STERILE STORAGE

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Clean/Sterile Storage

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OBJECTIVES

Following training, employees will be able to:

1. Explain the importance of sterile storage.
2. List the means by which sterility is maintained in SPD.
3. Discuss the environmental conditions necessary in SPD.
4. Define people flow and air flow.
5. Explain the proper way to handle and deliver medical supplies.
6. Discuss the two types of storage systems available and their benefits/drawbacks.
7. Define "FIFO" and the importance of stock rotation.

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CLEAN/STERILE STORAGE

1. Medical supplies and patient care equipment must be available at a moments notice to enable a hospital to provide quality care to its veterans. This necessity requires that an area be designated as a "sterile storage" area, where sterile supplies and instrument sets can be made available while protecting them from accidental contamination. In many VA hospitals there is no distinction made between sterile and nonsterile storage areas; all medical supplies are stored under the same conditions. This arrangement makes it easier to locate all like items in the same area while ensuring all patient care supplies are equally protected from contamination.

2. IMPORTANCE OF STERILE STORAGE

As already mentioned, one of SPD's tasks is to lower, even eliminate, the amount of microorganisms that may come into contact with a patient through the use of a variety



Technician in Sterile Storage Area

of medical supplies. The task is an important one. Each day SPD receives many instruments contaminated with blood and tissue from the Operating Room and other areas of the hospital. Supplies are received that have been in warehouses, trucks, and planes, and have been handled by many people before arriving at the hospital. Each of these items must be handled correctly in order to ensure sterility is maintained once it is achieved. The sterile storage area of SPD is designed with environmental and procedural controls which aid in the efforts to maintain the sterility of all products. In addition, the setup of the sterile storage area should assist in locating supplies quickly. When patient care items are needed right away, precious time should not be wasted searching up and down aisles for the correct product.

3. MAINTENANCE OF STERILITY

a. Once items have been sterilized and received in the distribution area of SPD, it is essential that each SPD technician do everything possible to protect and preserve the sterility of those items. Certain restrictive techniques have been established to help ensure that both sterile and nonsterile supplies are kept under the best possible storage conditions for the safety and protection of both patients and employees.

b. The use of tobacco products, applying cosmetics, eating, drinking, or storing food items (including beverages) will not be permitted in SPD. Such items can spoil and draw flies or vermin, leading to the contamination of medical supplies.

c. Portable fans will not be used in any area of SPD. The wind produced by the air may force microorganisms into the sterile packs through the minute holes and folds in the packaging material. Portable fans may also interrupt the proper air flow in SPD, forcing "dirty" air into a "clean" room.

d. Specific attire to be worn by distribution personnel includes the regular SPD uniform consisting of white pants and a blue smock. Head and beard covers must be worn in the case cart storage area of the clean/sterile storage. Only medical center issued clothing is authorized to be worn in this area. The purpose of this is to protect the supplies by preventing the transmission of bacteria from outside clothing to the products. If it is necessary for personnel to enter the sterile storage area wearing other clothing, they must don a cover gown or jacket. They must also wear a head covering if they enter the case cart area.

4. ENVIRONMENTAL CONTROL

a. Certain environmental conditions must be maintained in SPD to assist in the attainment and maintenance of sterility. These include temperature settings, humidity, air exchanges, and cleanliness. In addition, ensuring proper people flow, air flow, and work flow will help to prevent harmful microorganisms from ever entering the clean/sterile areas of SPD.

b. **Temperature** - The room temperature in all SPD areas is to be kept between 65 degrees and 72 degrees Fahrenheit.

Humidity - Humidity levels are to stay between 35 and 75 percent.

Air Exchanges - 10 air exchanges per hour are required.

c. **Cleanliness** - A regular schedule is set up with the Environmental Management Service for cleaning SPD. This is to include wet mopping or vacuuming all floors daily, using separate cleaning equipment for the decontamination area, and cleaning the walls in the preparation and decontamination areas monthly. SPD personnel are responsible for cleaning all work surfaces and sinks daily using an approved disinfectant, and other areas, such as storage shelves, breakout rooms (clean receiving), ward closets, and equipment storage areas on a regularly scheduled basis.

d. Specific attire to be worn by distribution personnel includes the regular SPD uniform consisting of white pants and a blue smock. Head and beard covers must be worn in the case cart storage area of the clean/sterile storage. Only medical center-issued clothing is authorized to be worn in this area. The purpose of this is to protect the supplies by preventing the transmission of bacteria from outside clothing to the products. If it is necessary for personnel to enter the clean/sterile storage area wearing other clothing, they must don a cover gown or jacket provided by SPD. They must also wear a head covering if they enter the case cart area.

e. The SPD area must be kept free of insects, rodents, and other vermin. Any sign of infestation should be reported immediately to the Chief, SPD, for investigation. A routine schedule for spraying SPD for pest control should be developed with Environmental Management Service.

f. **People Flow.** Traffic in SPD should be restricted only to authorized personnel. Only those having official business in SPD should be allowed access, and these persons should be accompanied by an appropriate SPD supervisor or designee. This is necessary to minimize the amount of microorganisms entering SPD on people and their clothing. Traffic patterns are designed to always move people from clean areas to dirty. No one should move from dirty to clean areas without following prescribed aseptic techniques.

g. **Air Flow.** Air flow is carefully controlled in SPD to minimize the movement of microorganisms from dirty areas to clean. This is controlled by creating a positive air flow in the clean areas of SPD. Positive air flow means that a greater amount of air is forced into a room than is exhausted. This forces the air to seek other routes of escape, i.e., through doors, service windows, and other cracks and crevices. Positive pressure makes it difficult for airborne particles to enter that space. The dirty areas of SPD are maintained under negative pressure. Negative pressure occurs when more air is exhausted from the room than is supplied, thus creating air flow into the dirty areas

through doors and minimizing the escape of airborne microorganisms. The positive flow in the clean areas of SPD is exhausted through the dirty areas to the outside or a filtered recirculating system.

h. **Work Flow.** Work flow refers to the order in which medical/surgical items are received into SPD, processed, and dispensed for patient use. Work flow in SPD should always move from dirty to clean. Soiled instruments and patient care equipment are received in the decontamination area. After being processed, they move to the preparation area for inspecting, packaging, and sterilizing, as necessary. They are then transferred to the sterile storage area and maintained until issued. Purchased medical supplies are received into SPD in a breakout area where they are removed from their outer shipping containers before being stored in the sterile area. Sterile supplies should never enter or be stored in the decontamination area; contaminated items should never enter SPD through the clean areas. Separation of clean and dirty must always be maintained.

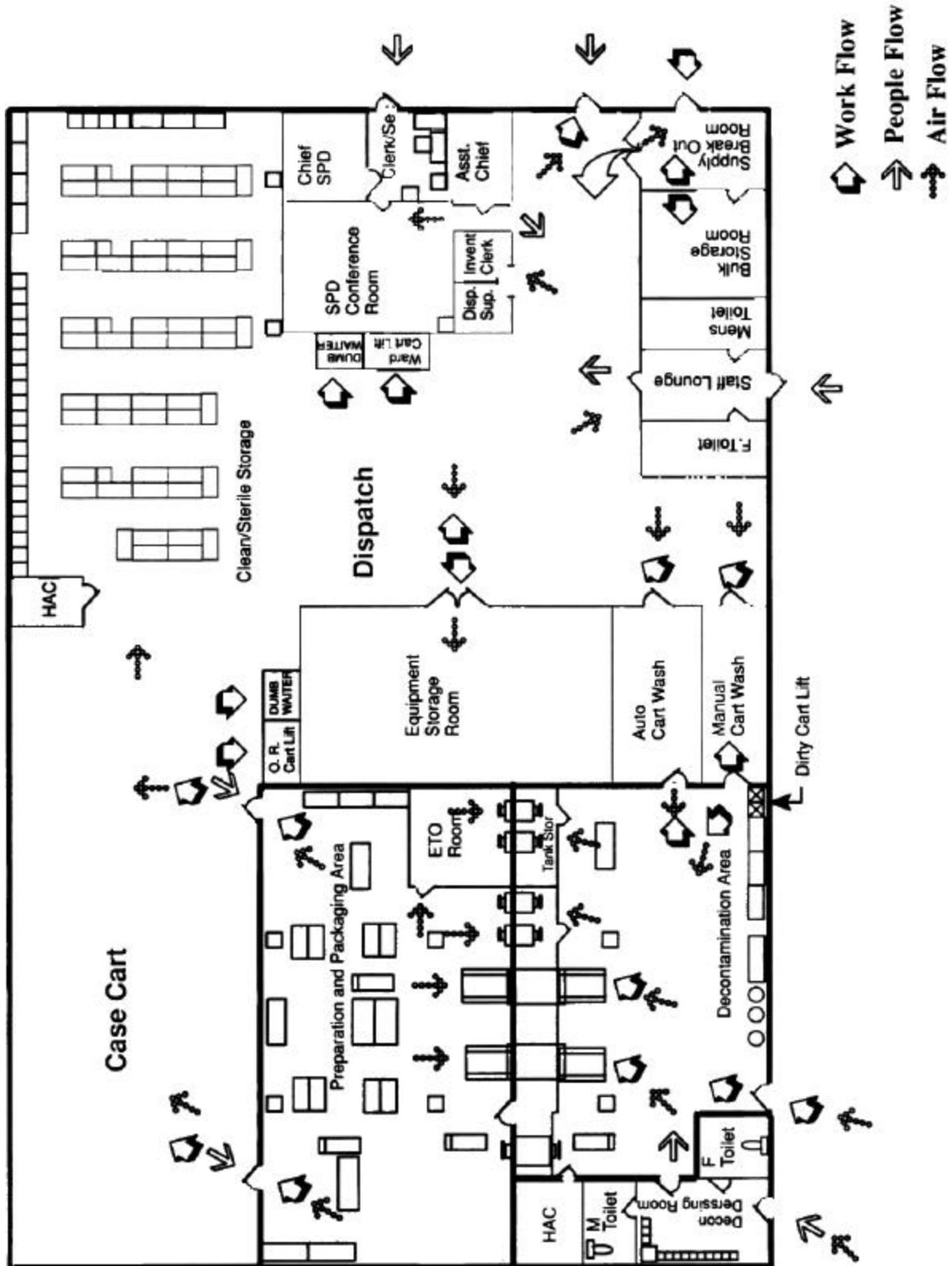
5. PRODUCT HANDLING

a. Environmental controls in SPD are not the only factors involved in ensuring that a quality product, either sterile or nonsterile, is provided to our customers. Also important is how that product is handled and stored.

b. As supplies are received in the breakout area of SPD, shipping containers are examined to ensure no damage has occurred during transport from the manufacturer. If boxes have been damaged, the contents should be examined for damage or contamination. Any questionable condition should be brought to the attention of the SPD Chief. Damaged products can often be returned to the manufacturer and replaced with acceptable ones.

c. Before any item is moved into the sterile storage area of SPD, it must be removed from its outer shipping container or corrugated box. These containers have been exposed to dusty, dirty conditions and may act as microbial harbors for a variety of organisms. Shipping containers and corrugated boxes should never be utilized as dispenser bins or storage containers. Ideally, SPD personnel should wear a cover gown over their uniform while breaking out items from their shipping containers. Care should be taken not to wear the dirty cover gown back into the sterile storage area.

d. All sterile supplies should be handled with extreme care to preserve package integrity and prevent contamination. Staples, paper clips, tape, or rubber bands must never be used in conjunction with the storage or delivery of supplies, whether sterile or nonsterile, as they may promote contamination. When carrying sterile items, they must never be compressed, such as placing them under the arm. This, too, compromises the integrity of the sterile package and promotes contamination of the contents. When delivering items, aseptic techniques should be followed. Items should not be carried



WORK FLOW

under the chin, in the teeth, etc.. Smaller amounts of items should be delivered in a bag, larger items should be delivered in/on carts.

6. STORAGE SYSTEM

a. There are basically two types of storage systems in use, open and closed shelving. Each offers certain benefits and drawbacks. Open shelving usually consists of wire shelves with movable dividers used to separate products. This type of shelving is the most common type of storage unit and offers the most efficient use of space. Open shelving also makes locating supplies easier when taking inventory or issuing products. When open shelving is used, care must be taken to adhere to prescribed clearances from walls, floors, and ceilings (including fixtures). A distance of 2 inches should be maintained between sterile supplies and outer walls due to possible condensation; approximately 18 inches between supplies and ceilings and ceiling fixtures, such as lights and sprinkler heads, to prevent interference with light and sprinkler operation; and all supplies should be at least 8 inches off the floor to prevent



Wire Shelving Unit

contamination from wet mopping. It is also advisable to have a solid bottom shelf on open shelving units to prevent dust, dirt, and water from being conveyed onto supplies located on the bottom shelf.

b. Closed shelving usually consists of metal cabinets, with standard type doors, or portable lockers, such as exchange carts with roll-type doors. Some say these systems offer added package protection because the supplies are not exposed to the



Closed Shelving and C-Locker

air on a continuous basis. However, there are some drawbacks to be considered. Many of these systems reduce the actual amount of storage space due to the size of each unit and the frame requirements. Care must also be taken in maintaining a neat, orderly arrangement of stock in these units; supplies can often be caught in the closing drawers and doors, resulting in damaged, unsterile products. Opening of the doors should also be done slowly to minimize the air movement into the shelving unit. A quick rush of air could force airborne microorganisms into the packaging (the "bellows" effect). Closed shelves and drawers often trap dust particles from the air and packages. Both types of shelving should be wiped down and cleaned with a hospital approved disinfectant on a regularly scheduled basis.

7. REPLENISHMENT OF SPD STOCK (INVENTORY REPLENISHMENT)

a. Periodically, inventories are taken of medical supplies in SPD. Both posted stock, those items stocked in the warehouse, and unposted stock, open marked procurements, are visually located to identify what needs to be ordered. With the advent of the General Inventory Package (GIP), it is possible to have the computer take over this function. With inventory levels entered into the computer and constantly updated with daily issue totals, regular orders for medical supplies can be autogenerated when supply levels in SPD reach the reorder point. Of course, this feature necessitates accuracy in counting the supplies issued every day.

b. When supplies are stocked in sterile storage, the practice of stock rotation is adhered to. The acronym "FIFO" or "First In, First Out" is employed. This means that the old supplies are issued before the new ones. On the shelf, supplies are pulled from the right and front first, and new supplies are stocked beginning on the left and back.

c. Each week, and prior to being issued, all sterile medical supplies should be checked for outdates. Outdated supplies are those whose expiration date has been passed. These items are no longer considered safe for use. Outdated sterile supplies should either be discarded or returned to SPD for reprocessing, if they are reusable. Stock rotation is important in reducing the number of outdated supplies and the costs associated with discarding and reprocessing medical supplies.

STERILE STORAGE TERMS

Air Flow
FIFO
GIP
Package Integrity
People Flow
Traffic Flow
Work Flow

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QUESTIONS

1. Why is it necessary for SPD to have a sterile storage area?
 - a. So nonsterile supplies can be received in a timely manner.
 - b. So sterile supplies can be received in a timely manner.
 - c. Because Pharmacy won't store the items.
 - d. To protect the supplies from contamination and damage until needed.
2. Which of the following items are not prohibited in the sterile storage area of SPD?
 - a. chewing tobacco and cigarettes
 - b. carbonated beverages and bottled water
 - c. delivery carts and patient care equipment
 - d. lipstick
 - e. candy bars
3. Why are portable fans prohibited in SPD?
4. What is the proper attire for SPD personnel working in distribution?
5. What personal protective equipment is required in sterile storage?
6. What range of temperatures is required in SPD
7. What humidity level must be maintained in SPD?
8. How many air exchanges are required for sterile processing and storage?
9. SPD personnel are responsible for cleaning:
 - a. the bathrooms, countertops, and ventilation ducts.
 - b. all work surfaces and sinks daily
 - c. nothing; Environmental cleans everything.
 - d. the refrigerator and microwave when they have unidentifiable growths in them.
10. "People flow" refers to:
11. Traffic in SPD should always move:
12. Air flow in SPD should always move:
13. Work flow should always move:

15. Outer shipping containers and corrugated boxes should:

- a. be checked for damage and contamination when received in SPD.
- b. never enter the sterile storage area of SPD.
- c. never be used as dispenser bins or storage containers.
- d. all the above.

16. The following should never be used in the storing or delivering of supplies:

- a. staples, paper clips, pins, rubber bands, or tape (other than sterilization tape).

17. Open shelving:

- a. is the most common type of storage system.
- b. offers the most efficient use of space.
- c. makes locating supplies easier to do.
- d. all the above.

DISTRIBUTION

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DISTRIBUTION



Nurse Server

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OBJECTIVES

Following training, the employee will be able to:

1. Discuss the role in supply support to user areas for patient care needs.
2. Identify and discuss the five main types of distribution methods utilized to ensure that medical supplies and equipment are delivered to the right place, in the right condition, at the right time.
3. Identify the types of specialty carts and their contents and uses.
4. Identify and discuss the different types of delivery methods and equipment.
5. Describe the procedures for delivery of clean and sterile patient care supplies to the user areas.
6. Describe the importance of equipment tracking.

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DISTRIBUTION

1. INTRODUCTION TO DISTRIBUTION

a. The distribution area is the center of the Supply, Processing and Distribution section. Its purpose is to stock, maintain, and distribute sterile and clean medical supplies and equipment to the user areas for patient care needs.

b. Most items are sent to the user areas via the dumb waiter, pneumatic tubes, or hand-carried. All stat items are hand-carried to ensure that these items are delivered promptly to the area in the critical time of need.

c. Medical supply technicians have the responsibility of stocking all user areas with patient care supplies and equipment. Supplies are stocked on a daily basis in supply closets or nurse-servers on each unit. Stocking of supplies in the nurse-servers provides the nursing staff with time to provide optimum care for the patients.

d. When clean and sterile supplies are needed in the user areas of the healthcare facility, they must be transferred from the SPD department to the point of use. This chapter will explain five main distribution methods that SPD departments may utilize to ensure the right product is delivered, in the right condition, at the right time.

2. TYPES OF DISTRIBUTION

There are five main types of distribution systems: **demand, par-level restocking, exchange cart, case cart, and specialty carts**. The type of system used depends on the services the healthcare facility provides, its size, physical design, age, resources, and mission. SPD management may periodically reevaluate their distribution systems in order to meet the current demands placed on the facility (i.e., census, finances). The important considerations in evaluating distribution systems are whether or not it provides information on future supply needs, the timeliness and accuracy with which supplies can be made available to the user, and how the system provides for control and documentation of inventory movement. It is important that the technicians be familiar with the characteristics, advantages, and disadvantages of each of the types of distribution systems. This way they can better understand why a particular system is used at their medical center, and how they can help make their distribution system as cost-effective, reliable, and efficient as possible.

3. DEMAND DISTRIBUTION SYSTEM

a. Every healthcare facility has used the demand distribution system (known also as a requisition and delivery distribution system), at one time or another. In this system, the staff of various user areas are responsible for maintaining an adequate level of supplies for use in that area. When supplies must be replenished, or an individual item

is needed, the user must prepare a requisition and request the necessary items, usually by telephone or in person. The SPD staff fills the order and delivers it to the user area by dumb waiter or in person. After delivery of the items, the requesting user is responsible for storing the items or transferring them to the point of use. This distribution system is generally carried out on a regularly scheduled basis or as necessary (needed), hence the term "**demand**" distribution system.

b. The demand distribution system is a simple process and has fulfilled supply needs for the healthcare facilities for many years. The **disadvantages** of the demand system are: the method is very labor-intensive, is generally unsuitable for high volume distribution in a large facility, and personnel in the user areas generally have patient care responsibilities and other priorities and do not have the time or the training to commit themselves to do adequate inventory control. Therefore, there is a tendency to maintain high levels of stock (hoarding) in the user area to eliminate frequent requisitioning and documentation. Maintaining excessively high inventories can be very costly to healthcare facilities.

4. PAR-LEVEL RESTOCKING DISTRIBUTION SYSTEMS

a. In this type of system an inventory or par-level is set for each stocked item used daily. These levels should be reviewed frequently and changed as necessary to reflect actual usage. The SPD technician is responsible for reviewing the levels daily as stock is being inventoried and maintained. The SPD technician should communicate with the customers in order to make necessary changes based on patient care needs. Supply closets, treatment rooms, and nurse-servers are used for storage of these supplies.

b. A typical procedure to maintain stock in the areas is to assign a technician to each area(s). The technician will inventory all supplies in the treatment rooms, supply closets, and other areas where supplies are stocked. The technician will return to the SPD department and have the inventory sheets filled by other technicians or themselves. When the supplies have been obtained, the technician then replenishes the user area with the preset "par-levels." Healthcare facilities utilizing nurse-servers for patient care supplies also use a par-level restocking system.

c. A listing of all needed supply items and levels are posted on the inside of the nurse-servers, therefore, the user and the SPD technicians will know what should be readily available at all times for patient care. The nurse-servers are stocked with supplies daily to bring supply levels up to "par" or preset levels. Nurse-servers are usually restocked from a mobile supply cart that contains all needed supplies. This cart is inventoried and restocked daily by the SPD technician. The par-level system is user friendly in that the users no longer have the time-consuming task of maintaining their own supply inventory, and inventories can be maintained at more optimum levels than in the demand system. In most healthcare facilities, this system provides an excellent means of tracking the use of patient care items.

d. The disadvantage of this system is that distribution is a timely process if the healthcare facility is large or spread over several areas. Some medical centers use a replenishment cart(s), which the SPD technician takes to each area for restocking medical supplies to par-levels. This procedure may require the technician to return to the SPD department frequently for restocking the replenishment cart(s).

5. EXCHANGE CART SYSTEM

a. The exchange cart system, like the par-level restocking system, has pre-set levels that have been established by the user and the SPD technician. In the exchange cart system, two identical carts are stocked with supplies. Once the levels of these carts have been established, one cart is placed in the user area and one in SPD. On a regular basis, the cart in the user area is returned to SPD and the identical (fully stocked) cart in SPD is exchanged in its place.

b. The exchange cart system is practical, flexible, dependable, easy to manage, and can be used in all healthcare facilities. This system allows for thorough documentation, good control of patient care supplies, and identification of lost stock. This distribution system can be extremely cost-effective through its control of inventory, time savings, and manpower. The disadvantages of this system are that duplication of stock and large amounts of space are needed for storage and handling of carts in the SPD distribution section. The cost to establish this system can be very expensive due to the initial purchase of the exchange carts and the additional inventory required to stock them.

6. CASE CART SYSTEM

a. In the case cart system, the operating room is provided with selected supplies for each surgery via a case cart system. These case carts have supplies and instruments that will be used for individual cases. The supplies and instruments for the case cart system can be provided by different methods, such as procedure cards, computer printouts, and requisition forms. The method used most frequently is the computer printout.

b. In this method, each surgery is generally assigned a computer number by SPD. When surgery receives the schedule, a computer number is assigned to each case accordingly. The surgery schedule is given to the SPD computer operator who generates a case cart listing for each surgery. These computer case cart sheets are given to the SPD technician who fills the case carts with supplies and instruments that are located in SPD. The cases are filled according to the time the surgery is scheduled for the next day. All scheduled first cases are delivered and placed in the operating room or clean corridor until time for use. All other case carts are delivered to the O.R. at the time of need. At the completion of the surgery, all contaminated supplies are placed within the soiled holding area. The carts are retrieved by SPD personnel and taken to the decontamination area for reprocessing. A major advantage for using the case cart system is the efficiency and cost savings that can be gained by concentrating

processing and inventory management expertise and equipment in SPD. Another advantage is the improvement of patient care during surgical intervention. By removing nonnursing activities, the nursing staff can spend more time on patient care and implementation of the nursing process.

c. Patient care and employee safety can be enhanced by the effective infection control that the case cart system provides. Important principles of confinement and containment can be provided by using a separate cart for each case. A closed case cart system provides for enhanced infection control. The implementation of a case cart system avoids costly duplication of effort, equipment, and inventory. When case carts are prepared for each procedure, there is better control of inventory which results in cost savings.

d. Initially, operating room personnel were concerned that SPD personnel were not trained or well prepared in the care and processing of instruments. Over the years this has changed. Healthcare facilities now offer all types of educational opportunities for SPD. Educational opportunities include on-the-job training, in-services given by product representatives and other professional staff members, and SPD certification training for employees at the VA medical centers. Continuing education training enables SPD personnel to upgrade their work practices and become more secure and confident about their jobs.

e. Once personnel are properly trained and communication between the operating room and SPD is established, the turnaround time for instrument processing is greatly reduced. An increase in instrument inventory will be required to implement the case cart system effectively.

f. One other factor to be examined before initiating a case cart system is the proximity of the O.R. to SPD. The most desirable scenario is to have the SPD department area located either adjacent to the operating room or one level above or below. If possible, a dedicated transport system between the operating room and SPD should be planned for transfer of supplies and equipment. The same procedures for traffic control and dress attire should be adhered to in SPD preparation areas as in the operating room.

7. SPECIALTY CARTS

a. **Specialty carts** are carts that contain supplies needed in emergency or special situations. The types of specialty carts are: **disaster**, **implant**, **crash or code carts**, and **special procedure carts**, such as **arterial line carts**, **central line carts**, **Swanz Ganz carts**, **urology carts**, and **suture carts**.

b. **Disaster carts** are stocked with medical supplies needed for use in a sudden community misfortune, such as a large traffic accident, bombing, or flood. These

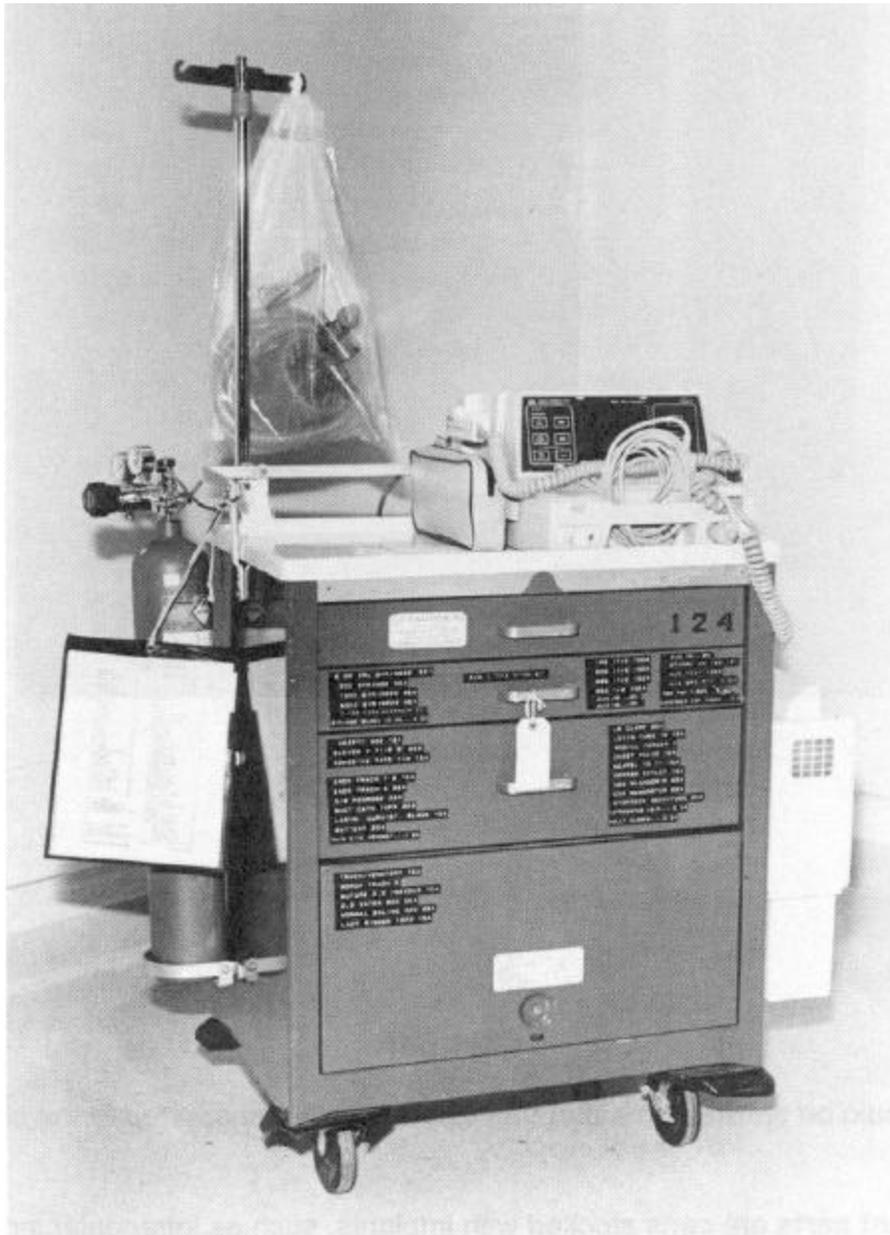


Case Cart

supplies should be stocked on a cart that can be easily transported to the scene of the disaster.

c. **Implant carts** are carts stocked with implants, such as intraocular lens, vascular grafts, knee, and hip prosthesis that are transported to the operating room at the time of the specific surgery.

d. **Crash** or **code carts** are specialty carts used in emergency situations to revive victims from respiratory failure or cardiac arrest. These carts are stocked with medical supplies by SPD personnel, and drugs and intravenous solutions are stocked by the pharmacy department. **Code** or **crash carts** containing supplies and drugs are to be kept locked to secure their contents. Filled crash carts are maintained throughout medical facilities so that they can be utilized quickly during emergencies. Backup



Crash Cart

crash carts are readily available in SPD for exchange when one is used. The outside of the **code** or **crash cart** should be inspected daily by hospital personnel to ensure the security of the cart and exterior supplies and equipment. The outside of the **code** or **crash cart** will contain a listing of all supplies that are needed. The outside of the carts should be checked daily for drug expiration dates. SPD employees should read the policy and procedures manual at their VA medical centers to know their role and what is expected of them during an emergency situation.

8. DELIVERY METHODS AND EQUIPMENT

a. Several methods and types of equipment are used to deliver and store medical supplies. **Distribution carts** are used to transport and store supplies. **Dumbwaiters** and other mechanical devices are used to transport small quantities of supplies to the point of use upon request. **Nurse-servers** are small cupboards that are used to store supplies for individual patient care. In emergency situations, SPD personnel may be requested to deliver items "**stat**" ("**stat**" meaning **immediately**). "**Stat**" supplies should be delivered by the fastest method available, preferably hand delivered. Hand delivery will ensure the needed items reach the point of use as soon as possible.

b. Mechanical devices cannot ensure that "**stat**" items reach their destination. There could be a power failure or electrical outage. Users can obtain items directly from SPD by coming to the department. This is called **window distribution**, which is utilized by some healthcare facilities.

c. The SPD distribution area should be cleaned on a regular basis; this includes **conveyors, storage areas, and transport vehicles**. These items should be cleaned with a germicidal solution.

9. DISTRIBUTION WORK PRACTICES

SPD personnel must remember that careful handling and timely delivery of supplies are needed in the patient care area. If not, the user may lose confidence in our services. This will cause the users to hoard supplies resulting in duplication which can be costly. Patient care can be adversely affected if an item is not delivered, in the right condition, at the right time.

10. SELECTION OF ITEMS FROM INVENTORY

The distribution process begins when a request is received for supplies or equipment. These items should be handled carefully to avoid damage or contamination. The type and quantity should be verified before transporting to the point of use. All sterile items processed by SPD should be checked for **expiration date, external chemical indicator** (to verify the item was subjected to the sterilization process), and that the packaging is not damaged, wet, or soiled. These items should be properly labeled before being transported to the point of use. Commercially prepared sterile items

should also be inspected for expiration dates and that the package is not damaged, wet, or soiled.

11. DELIVERY OF ITEMS TO PATIENT CARE AREAS

During transport, clean and sterile supplies should be covered or enclosed to protect the supplies from the environmental hazards. Distribution carts, that are used for the transport of sterile supplies, should have a barrier or solid bottom shelf protecting the supplies from the wheels and floor. Items that fall on the floor during transport should not be used, they must be returned to SPD for reprocessing or disposed. Clean/sterile supplies should never be transported on the same carts or in the same containers as contaminated supplies. Each VA medical center should implement a transportation system in order to keep clean/sterile items separate from contaminated items. SPD personnel should use caution when transporting heavy carts and use proper body mechanics to avoid injury. SPD technicians should never leave distribution carts unattended. Leaving carts unattended could cause patient/employee injury, lost and theft of supplies, and contamination of sterile supplies.

12. EQUIPMENT TRACKING

Each VA medical center has a procedure for tracking medical equipment. Some facilities track equipment by using a peg board, cardex, alphabetical file, or a computer system. Each piece of equipment should be accounted for and safety inspections completed when required. Equipment should never be delivered to the point of use if it has not been inspected or is not functioning properly in order not to jeopardize patient care.

DISTRIBUTION TERMS

Distribution Area
Demand System (Requisition and Delivery Distribution)
Par-Level Restocking Distribution System
Exchange Cart System
Case Cart System
Speciality Carts

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QUESTIONS

FILL IN THE BLANKS

1. _____ carts are used to transport and store supplies.
2. Two mechanical devices used to transport small quantities of supplies are _____ and conveyors.
3. Small cupboards used to store supplies for individual patient care are called _____.
4. In emergency situations, SPD. personnel may be requested to deliver items "stat" meaning _____.
5. "Stat" supplies should be delivered by the _____ method available, preferably hand delivered.
6. Specialty carts are carts that contain supplies needed in _____ or _____ situations.
7. The types of specialty carts are _____, _____, and _____ or _____ carts.
8. The exchange cart system has preset levels that have been established by the _____ and the _____.
9. In this system _____ carts are stocked with supplies.
10. The levels of these carts are established and _____ on a daily basis.
11. Advantages of the exchange cart system are _____, _____, and easy to _____.
12. The exchange cart system can be used in _____ healthcare facilities.
13. The exchange cart system can be _____ because of duplication of supplies.
14. One of the disadvantages of this system is the need for a _____ amount of space.
16. This system allows for thorough _____, _____ of patient care and _____ of lost stock.

TRUE/FALSE

17. Mechanical devices cannot ensure that "stat" items reach their destination.
18. When users come directly to SPD and receive supplies, this is called window distribution.
19. In all healthcare distribution sections, the area should be cleaned weekly.
20. Careful handling and timely delivery of supplies are key components in any distribution system.
21. Users never lose confidence in SPD just because supplies are in a little late getting to them.
22. In this system, a level is not set but is based on workload.
23. The user is responsible for reviewing the levels daily.
24. The computer generated inventory sheet should have the following information: item number, nomenclature, levels, and location.
25. Nurse-servers do not have a pre-set level of supplies and are stocked according to workload.
26. Nurse-servers are stocked from a mobile supply cart that contains all needed supplies.
27. With the par-level system, the user has to maintain their own supply inventory.
28. Healthcare facilities that use this system provide good means of tracking the use of patient care items.
29. The disadvantage of this system is that distribution can be slow if it is used in a large hospital.
30. With this system, the SPD technician might have to return to SPD for additional supplies.
31. Disaster carts are specialty carts used in emergency situations to revive victims from respiratory failure or cardiac arrest.
32. The drugs in the crash or code carts are stocked by warehouse personnel.
33. The code or crash carts are usually kept secure by a small lock.

34. SPD personnel should check code or crash carts daily to ensure the security of the carts.
35. SPD personnel should read the policy and procedures manual to understand their role and what is expected of them during an emergency situation involving a crash or code cart.
36. The implant cart should be used if someone suffers cardiac arrest.
37. In the event of a natural disaster, the cart that would be called for is the disaster cart.

Multiple Choice

38. What would cause a user to hoard supplies:
- a. Greed
 - b. Taught in nursing school
 - c. The inability to receive supplies in a timely fashion
 - d. Cost may go up if not hoarded
39. Before sending supplies to users they should be checked for:
- a. Expiration date
 - b. External chemical indicator
 - c. Damage
 - d. All of the above
40. Distribution carts that are used for the transport of sterile supplies should have:
- a. Open bottom
 - b. Barrier or solid bottom
 - c. Bumpers
 - d. Turn signals
41. Some facilities track equipment by:
- a. Using peg boards
 - b. Cardex
 - c. Computer system
 - d. All of the above

42. Equipment should not be delivered to the floors before it is:

- a. Cleaned and inspected
- b. Sterilized
- c. Run through an EtO cycle
- d. Asked for

INVENTORY MANAGEMENT

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Inventory Management



Closed Shelving

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OBJECTIVES

Following training, the employee will be able to:

1. Identify the importance of inventory management.
2. Define IFCAP, GIP, and their functions.
3. List and define inventory systems.
4. List and define stock levels.
5. Explain the function of the Commodity Standardization Committee.
6. Define: picking ticket, primary, secondary.
7. List some of the most commonly used GIP-generated reports.
8. Explain available alternate distribution systems.
9. Discuss overstocking and understocking.
10. Describe the storage design in SPD.

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INVENTORY MANAGEMENT

1. Inventory management is the responsibility of each employee. It is essential to the overall cost control within a medical center. Emphasis on cost containment, reducing waste (time and money), standardization of products, and streamlining efforts has grown tremendously. Controlling the cost of medical supplies and equipment through competitive procurement sourcing, waste reduction, and elimination of unofficial and stagnant inventories has a tremendous effect on cost containment.
2. The inventory management process consists of IFCAP (Integrated Funds Distribution, Control Point Activity, Accounting, and Procurement) and GIP (General Inventory Package). These computer systems require considerable time and effort to initiate and maintain, and are only as reliable as the information put into it. However, the advantage over manual systems is the rapid availability of a multitude of information.
3. The IFCAP inventory system is used to manage the receipt, distribution, and stock maintenance of items received from the supply warehouse and/or outside vendors. IFCAP provides information on supplies, equipment, vendors, procurement history, and control point activity. SPD's control point is the budget used to requisition medical/surgical supplies and some equipment.
4. Effective inventory management is essential to overall cost control within a medical center. In past years, the emphasis on cost containment, reducing waste (time and money), and streamlining efforts has grown tremendously. Controlling expendable supplies, disposables, and "unofficial" inventories may have a major impact on cost containment.
5. One purpose of inventory management is to ensure the availability of the items that the user needs in the quantity in which they need them. Another purpose is cost containment. The aim is to purchase in quantities to receive premium pricing from the vendor without tying up funds in overstocked shelves.
6. A variety of inventory systems are in place to accomplish this control:
 - a. **par-level** - levels are established in conjunction with the users of specific items to be stocked in the using area. On regular intervals, the user's inventory on hand is evaluated against their level, and the amount needed to bring the items back to that level is pulled from SPD and added to the user's inventory.
 - b. **demand** - the user maintains supply levels and, as supplies are needed, they request the supplies from SPD. SPD fills the requisition and delivers to the user who stores the items.

c. **exchange cart** - two identical carts are created with the items requested by the user at the levels required. A fully-stocked cart is kept in SPD and the other is in the using area. At regular intervals (usually daily), the carts are exchanged and the used cart goes back to SPD to be restocked.

d. **case cart** - used for total supply support to the O.R. Case cart sheets are devised by procedure with all supplies and instruments required for the particular procedure. By following the daily surgery schedule, the items are pulled, placed on the case cart, and delivered to the O.R.

e. **specialty cart** - disaster carts, crash carts, etc.; carts created for specific uses, continually available, and used as necessary.

7. There are a variety of delivery systems that can be utilized by SPD to deliver supplies to the users. They include:

a. **manual carts** - used to physically transport supplies throughout the medical center. May also be used with automated transport systems.

b. **dumbwaiters** - small, dedicated lifts for transport of supplies to using areas.

c. **pneumatic tubes** - transport small items able to withstand negative pressure.

d. **automated transport systems** - augments manual delivery through a system of programmed routes and schedules.

e. **call window** - allows users to obtain items directly from SPD.

8. The tools of the inventory management process include IFCAP (Integrated Funds Distribution, Control Point Activity, Accounting, and Procurement) and GIP (General Inventory Package). These computer systems require considerable time and effort to initiate and maintain, and are only as reliable as the information put into them. The advantage over manual systems is the rapid availability of a multitude of information.

9. GIP is a portion of IFCAP used to manage inventory within SPD using areas. GIP consists of primary inventories and secondary inventories. The primary inventory is the SPD inventory and the secondary inventories are the points of distribution. Other primary inventories within the medical center include Pharmacy and Warehouse. They also have their own secondaries.

10. Within GIP, the SPD inventory (primary inventory) consists of all items stocked and/or procured by SPD. Stock levels are established to maintain constant availability of items. These stock levels are:

a. **normal stock level** - represents the largest amount of an item to be maintained in the primary (on SPD shelves).

b. **standard reorder point level** - represents the level at which the item is to be reordered.

c. **optional reorder point level** - alerts you that the level of an item has fallen below the normal stock level but has not yet reached the standard reorder point level. This allows you to include items very near their reorder point in upcoming purchases with the same vendor, thereby reducing separate purchases to the same vendor within short periods of time.

d. **emergency stock level** - represents the smallest amount of an item to be maintained in the primary. This level alerts you that an emergency purchase is required.

11. Standardization of medical supplies and equipment at the medical center is very important to deter the rapidly rising cost and duplication of medical supplies. The Commodity Standardization Committee and related subcommittees review and evaluate products for use in the medical center in order to maintain a state-of-the-art and quality medical service, as well as reduce the number, sizes, kinds, and grades of items.

12. GIP contains the ability to "autogenerate" orders. This is where the computer automatically reviews preset inventory levels against current amounts on hand and identifies those items below the preset levels in order that they may be requisitioned.

13. Computerized labels identify each item within the inventory. The medical supply technician uses a bar code reader to scan the label to identify the item and then enter the actual amount present. After scanning a secondary inventory, the information is uploaded into GIP and a picking ticket is generated. The picking ticket identifies the items and amounts required to be restocked in that secondary to return to preset levels.

14. All inventories maintained in user areas are called secondary inventories. Within GIP, secondary inventories are also maintained with stock levels and reorder points. Secondaries may be maintained by SPD or the user.

15. Primary and secondary inventories are reviewed on a regular basis utilizing GIP - generated reports, including:

a. **History of Distribution Report** - shows the total dollar amount of supplies distributed to each secondary. This information is useful in computing quarterly and annual budget reports.

b. **Inactive Item Report** - gives a list of items for a specific period of time that have been inactive.

c. **Cold/Hot Usage Report** - used to evaluate item usage. "Cold" items show a decrease in usage and may need to have their stock level decreased. "Hot" items show an increase in usage, and their levels may need to be increased.

e. **Emergency Stock Level Report** - gives a list of items with levels at or below the emergency stock level, and also shows whether or not there is an outstanding order for the item.

16. Alternative distribution systems are becoming available for use by medical centers to drastically reduce the amount of stock they must keep on hand and/or to reduce expenditures. A few of these systems are:

a. **Consignment** - a vendor maintains a portion of the primary inventory on the shelves and bills the medical center once a month for items used during that period. Consignment is considered a "no cost" inventory program because the medical center pays nothing until items are used. In addition, the vendor many times will purchase the inventory on hand of the items delineated as consignment items, thereby producing a substantial influx of funds.

b. **Prime Vendor** - a single vendor serves as distributor for a portion of the SPD primary inventory, regardless of brand or manufacturer. They provide next-day delivery which allows SPD to greatly reduce the amount of stock on hand.

c. **Just-in-Time (JIT)** - a concept where the costly inventories are reduced by eliminating the primary inventory. JIT allows secondary inventories to be stocked on a regular basis by providing medical supplies just-in-time. This system works best when needs can be easily and accurately forecasted.

d. **Stockless** - a system where there is no primary inventory. Stock is delivered by vendors on an as-needed basis, prepackaged, 2-3 times per day, 7 days a week.

17. It is important to avoid overstocking and understocking in both the primary and secondaries. Overstocking ties up a considerable amount of money in stock, and increases the risk of damage, outdating, contamination, or obsolescence of the item. Understocking creates the risk of unavailability of supplies which affects the quality of patient care. It also creates additional purchase costs (overnight shipping) and adversely affects the trust users have in SPD.

18. Every effort is made to have all items available at all times, a 100 percent fill rate. However, the realistic goal is to make sure critical items are available at all times, while less critical items may be on "back-order." Hospitals that are in close proximity may borrow items in terms of emergency.

19. The storage in SPD should be designed to promote cleanliness, visibility, safety, and efficiency of distribution. The inventory should be verified on a regular basis for outdated items and damaged or obsolete items. With a minimum of handling, the risk of damage or contamination is greatly reduced. The rotation of stock is vital to prevent unnecessary outdates and additional costs.

20. Everyone involved with stocking, distribution, record keeping, or any other aspect of inventory management must strive to keep errors to a minimum. One mistake in distribution allowed to remain over days or weeks will render value, quantity, or other information erroneous and unusable. Regular counts should be done to verify and update the accuracy of the inventory. Accurate inventory management saves money, saves storage space, and promotes trust and confidence by users and patients.

ORDERING FROM VENDOR: VA SUPPLY
 REPETITIVE ITEM LIST NUMBER: 564-95 1-041 822100-0014

MI# DESCRIPTION PRIMARY VENDOR ISSUE ISSUE
 UNIT/ISS UNIT/ISS MINIM MULT

GROUP CATEGORY: GEN: GENERAL (6277)

586 SLIPPERS-BEIGE-LARGE-ADULT 1/PR 1/PR 48
 ONHAND INQUEIN -DUEOUT =AVAIL STAND (PTN) LEVEL CONV ORDER UNIT#
 103 0 10 96 125* 125 160 1 192 0.790

588 SLIPPERS-NAVY-BLUE-X-LARGE-ADULT 1/PR 1/PR 48
 ONHAND INQUEIN -DUEOUT =AVAIL STAND (PTN) LEVEL CONV ORDER UNIT#
 19 0 17 18 25* 25 100 1 144 0.680

7026 SOAP-BAR-INDIVIDUAL-1000 -PK 1/EA 1000/PK
 ONHAND INQUEIN -DUEOUT =AVAIL STAND (PTN) LEVEL CONV ORDER UNIT#
 495 0 0 495 500* 500 1000 1000 1 49.560

GROUP CATEGORY: V/B: ISSUESBOOK (6480)

5960 ACCESS PIN-AP-3100-100- CS 1/EA 100/CS
 ONHAND INQUEIN -DUEOUT =AVAIL STAND (PTN) LEVEL CONV ORDER UNIT#
 0 0 0 0 50* 50 100 100 2 144.647

620 CATHETERIZATION SET-URETHRAL-SUR-01 1/EA 10/EX
 ONHAND INQUEIN -DUEOUT =AVAIL STAND (PTN) LEVEL CONV ORDER UNIT#
 11 0 2 9 10* 10 20 10 2 77.450

4912 CUP-STYROP-DAY-60/-LH-PK 25/PR 1000/PK
 ONHAND INQUEIN -DUEOUT =AVAIL STAND (PTN) LEVEL CONV ORDER UNIT#
 43 0 10 13 20* 20 40 40 1 8.750

343 ELECTRODE-ELECTROCARDIOGRAPH DISP-P 1/EA 1/EA 240
 ONHAND INQUEIN -DUEOUT =AVAIL STAND (PTN) LEVEL CONV ORDER UNIT#
 240 0 0 240 120 240* 240 1 240 0.433

4070 GLOVE-EXAM-LATEX-LNS-SMALL 100/PG 100/PG
 ONHAND INQUEIN -DUEOUT =AVAIL STAND (PTN) LEVEL CONV ORDER UNIT#
 20 0 5 15 15* 15 30 1 15 5.292

4390 GLOVE-SURGEONS-STERIL (S-50 -TG 1/PR 50/PG
 ONHAND INQUEIN -DUEOUT =AVAIL STAND (PTN) LEVEL CONV ORDER UNIT#
 97 0 0 97 100* 100 100 50 3 23.102

1760 NEEDLE-CONTAINERS-W/01-MOUNTED-300 1/EA 30/CS 1 1
 ONHAND INQUEIN -DUEOUT =AVAIL STAND (PTN) LEVEL CONV ORDER UNIT#
 13 0 4 7 15* 15 30 30 1 63.841

4004 SPONGE-LAPAROTOMY-STERILE 5/PG 1/PG 40
 ONHAND INQUEIN -DUEOUT =AVAIL STAND (PTN) LEVEL CONV ORDER UNIT#
 11 0 0 11 20* 20 40 1 40 1.440

5931 SHAPSTICK POVIDONE-IODINE-10X 3/PG 250/CS
 ONHAND INQUEIN -DUEOUT =AVAIL STAND (PTN) LEVEL CONV ORDER UNIT#
 60 0 0 60 75* 75 150 125 1 39.600

5106 TAFE-PAPER-2-INCH 1/PR 1/PG
 ONHAND INQUEIN -DUEOUT =AVAIL STAND (PTN) LEVEL CONV ORDER UNIT#
 3 0 0 3 12* 12 24 1 3 4.350

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IMPORTANT TERMS – INVENTORY MANAGEMENT

Autogenerate
Automatic Transport System
Bar Code Reader
Call Window
Case Cart
Cold/Hot Usage Report
Commodity Standardization Committee
Control Point
Consignment
Demand
Dumbwaiter
Emergency Stock Level
Emergency Stock Level Report
Exchange Cart
GIP
History of Distribution Report
IFCAP
Inactive Item Report
Just-in-Time
Manual Cart
Normal Stock Level
Optional Reorder Point Level
Overstocking
Par Level
Picking Ticket
Pneumatic Tube
Primary
Prime Vendor
Secondary
Specialty Cart
Standard Reorder Point Level
Stockless
Under stocking

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QUESTIONS

1. It is important to reduce and/or eliminate _____ inventories in the medical center.
2. Inventory control ensures _____ of items.
3. Supplies and instruments required for surgical procedures are provided in/on _____.
4. A _____ cart is stocked and kept available for emergencies.
5. A _____ cart is often used by SPD technicians to physically transport supplies throughout the medical center.
6. User's obtain supplies directly from SPD using a _____.
7. SPD utilizes the _____, or GIP, for inventory management.
8. The inventory within SPD is called the _____ inventory.
9. The vendor providing a portion of the SPD inventory on a next-day basis is the _____.
10. The _____ Report is used to evaluate item usage.
11. Levels are established and items replenished to maintain that level is
 - a. demand
 - b. par level
 - c. call window
 - d. exchange cart
12. Small dedicated lifts for transport of supplies are
 - a. elevators
 - b. dumbwaiters
 - c. supply lifts
 - d. case carts
13. The level representing the largest amount of an item to be maintained is
 - a. optional
 - b. standard
 - c. normal
 - d. emergency

14. Used for total supply support to the O.R:
- a. specialty cart
 - b. call window
 - c. exchange cart
 - d. case cart
15. The advantage of computerized inventory systems is
- a. less writing
 - b. more correct information
 - c. rapid availability of information
 - d. all of the above
16. Inventories maintained in using areas are
- a. secondary inventories
 - b. customer inventories
 - c. user inventories
 - d. patient inventories
17. Overstocking
- a. ties up money in inventory
 - b. crowds shelves
 - c. increases risk of damage
 - d. all of the above
18. Storage in SPD should promote
- a. safety
 - b. visibility
 - c. cleanliness
 - d. all of the above
19. Everyone in inventory management must strive to
- a. keep a positive attitude
 - b. keep errors to a minimum
 - c. keep stock outages from public knowledge
 - d. keep shelves full at all times

20. Accurate inventory management

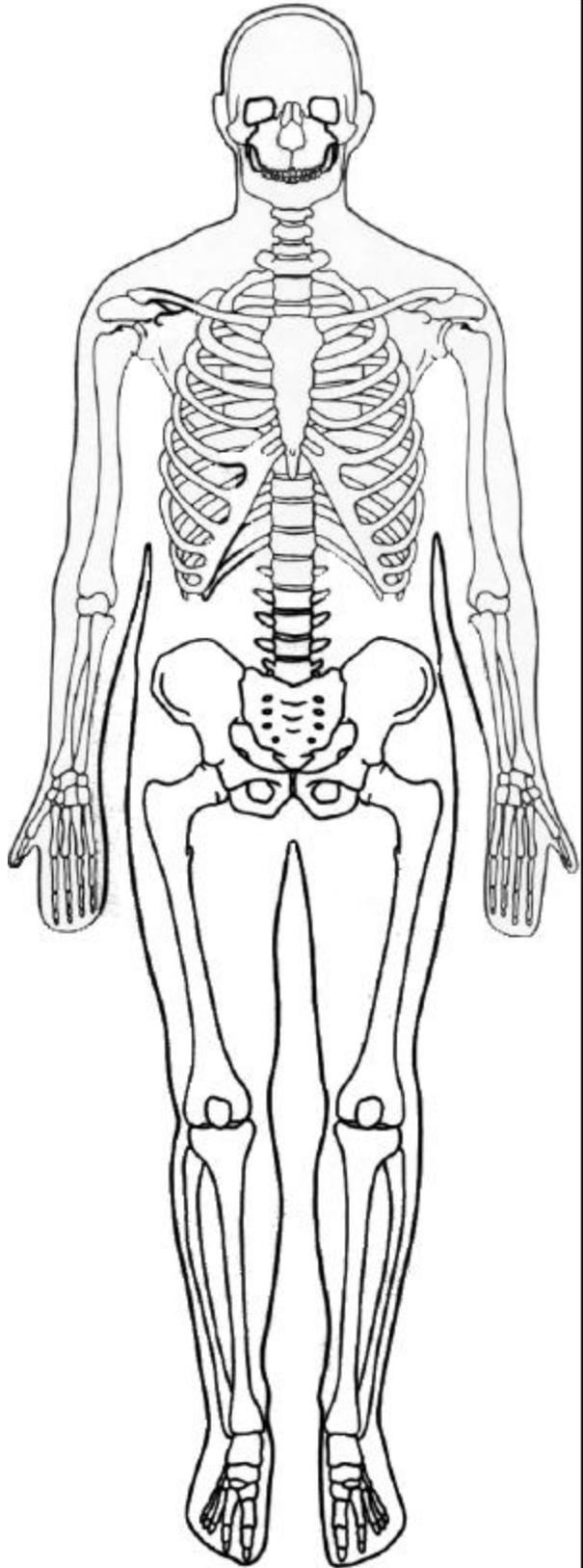
- a. saves space
- b. promotes trust
- c. keeps patients happy
- d. a & b

ANATOMY AND PHYSIOLOGY

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OBJECTIVES

Following training, the employee will be able to:

1. Define anatomy, physiology, systems, and cytology.
2. Describe the skeletal system and its role in the human body.
3. Identify the anatomical positions of the major bones within the skeletal system.
4. Describe the joints/articulation system and its role in the human body.
5. Identify the different types of articulation types within the human body.
6. Describe the muscular system and its role in the human body.
7. Identify the anatomical positions of the major muscles in the human body.
8. Describe the nervous system and its role in the human body.
9. Identify the anatomical positions of the structures of the nervous system.
10. Identify the anatomical positions of the structures of the eye and ear.
11. Describe the vascular system.
12. Trace the flow of blood through the heart.
13. Define the difference between oxygenated and unoxygenated blood.
14. Define blood and its use within the human body.
15. Explain the role of the lymphatic system.
16. Describe the respiratory system and its role in the human body.
17. Explain the differences between inspiration, expiration, and ventilation.
18. Identify the anatomical positions of the organs of the respiratory system.
19. Define the process of respiration.
20. Describe the alimentary system and its role in the human body.

21. Identify the anatomical positions of the organs of the alimentary system.
22. Describe the process of digestion.
23. Describe the urogenital system and its role in the human body.
24. Identify the anatomical positions of the organs of both the female and male urogenital systems.
25. Describe how the body filters waste by way of the urinary system.
26. Explain the role of the female and male reproductive organs.
27. Describe the process known as fertilization.
28. Describe the chemical role of the endocrine system.
29. Identify the anatomical positions of the female and male endocrine organs.
30. Explain the role of the integumentary system.
31. Identify the anatomical positions of the integumentary organs.
32. Label the parts of a cell.
33. Describe the differences between mitosis and meiosis.
34. Describe the biological, radiation, chemical, and physical hazards that put us at risk for the development of cancerous cells.

HUMAN ANATOMY AND PHYSIOLOGY

1. This chapter gives a general overview of **anatomy**, **physiology**, and **cytology**.

Medical supply technicians need basic knowledge of human anatomy, physiology, and cytology in order to understand the reasons for policies and procedures regulating the processing, storing, and distribution of supplies and equipment used for patient care.

2. **Anatomy** is defined as the study of the structure of the human body. **Physiology** is defined as the study of the functions of the human body. The human body is made up of 10 systems, which will be reviewed in this chapter. A **system** is defined as a group of organs working together to achieve common goals. These 10 systems are the **skeletal, joints or articulations, muscular, nervous, vascular, respiratory, alimentary, urogenital, endocrine, and integumentary systems**. The basic building block of all living things is called a cell. Its structure and functions will also be discussed.

3. The Skeletal System

a. The **skeletal system** forms the hard framework which contains the human body systems. The skeleton system is made up of 206 bones classified by their shape. There are four shape classifications: **long** (bones of the legs and arms), **short** (bones of the fingers and toes), **flat** (such as ribs), and **irregular** (bones of the skull and pelvis). See the illustration for the anatomical position and medical names of the human skeletal, articulation, and muscular systems.

b. The study of bones is called **osteology**. Bones provide the general framework of the human body. They are held in place by strong fibrous bands called **ligaments** which form joints or articulations.

c. Muscles are attached to the bone across the joints. Muscular contractions allow for movement of the bone at the joint. This interaction produces movement. The skeletal system also provides protection to the vital internal organs, such as the brain, heart, lungs. Calcium and phosphorus make up the large percent of its mineral content. These minerals make bones hard and dense, thus making them excellent materials for use in the framework, movement, and protection of vital organs.

d. **Bone marrow** is a soft, fatty tissue which is found in most bones. There are two types of marrow, yellow and red. Bone marrow is where red and white blood cells are formed and passed into the blood stream.

e. The following terms are used to describe the skeletal system:

cephal – head

crano - skull

osteo - bone

sacro - sacrum (tailbone)

thoraco – chest

ischi - hip

calc - foot (calcaneous bone)

capit - head

costa - rib

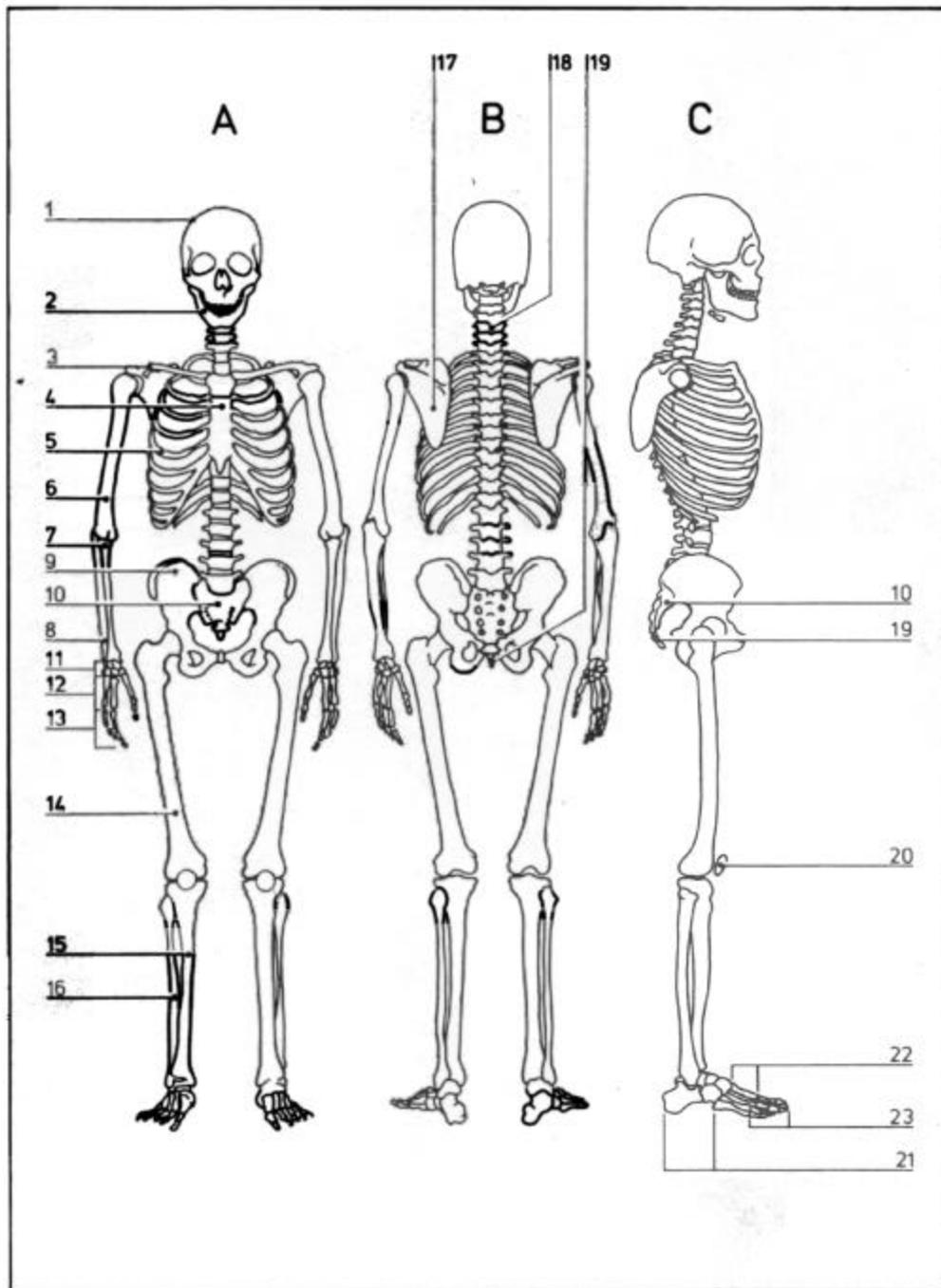
crur - leg

dactyl - finger

oss - bone

f. **Osteomyelitis**, for example, is the inflammation of a bone. A **craniotomy** is any operation on the cranium (skull), and the instrument that would be used to cut the cranium is a **craniotome**.

SKELETAL SYSTEM



- | | | |
|---------------------|----------------------------|----------------------|
| A Front view | 8 Ulna | 19 Coccyx |
| B Rear view | 9 Hip bone | 20 Patella |
| C Side view | 10 Sacrum | 21 Tarsus |
| 1 Skull | 11 Carpus | 22 Metatarsus |
| 2 Mandible | 12 Metacarpus | 23 Phalanges |
| 3 Clavicle | 13 Phalanges | |
| 4 Sternum | 14 Femur | |
| 5 Ribs | 15 Tibia | |
| 6 Humerus | 16 Fibula | |
| 7 Radius | 17 Scapula | |
| | 18 Spinal vertebrae | |

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JOINTS/ARTICULATION SYSTEM

1. The study of joints is called **arthrology**. There are three types of joints/articulations found throughout the human body. **Fibrous** joints allow only slight movement, such as the bones of the skull. The movement required in the skull is basically for growth. As the human body matures, this union hardens and does not allow movement. Fibrous joints (skull, teeth to the jaw bone) are held together by **ligaments**. Fibrous ligaments are tough collagenous bundles that allow as little movement as possible.

2. **Cartilagenous joints** are held together by cartilage and are slightly moveable. The spinal column is an example of a cartilagenous joint. The spinal cord can allow for bending and receiving the impact of the force of walking. A thick disk of cartilage connects the vertebrae and allows for bending and twisting of the spinal column.

3. **Synovial joints** allow for free movement. The shoulder, elbow, and leg joints are examples of this type of joint. In this type of joint the ends of the bone are connected by ligaments and cartilage, but separated by a cavity filled with **synovial fluid**. Synovial fluid helps lubricate and protect this free movement joint. See illustrations for joint/articulation types.

4. The following terms are used to describe the joint/articulation system:

artho - joint

chondro - cartilage

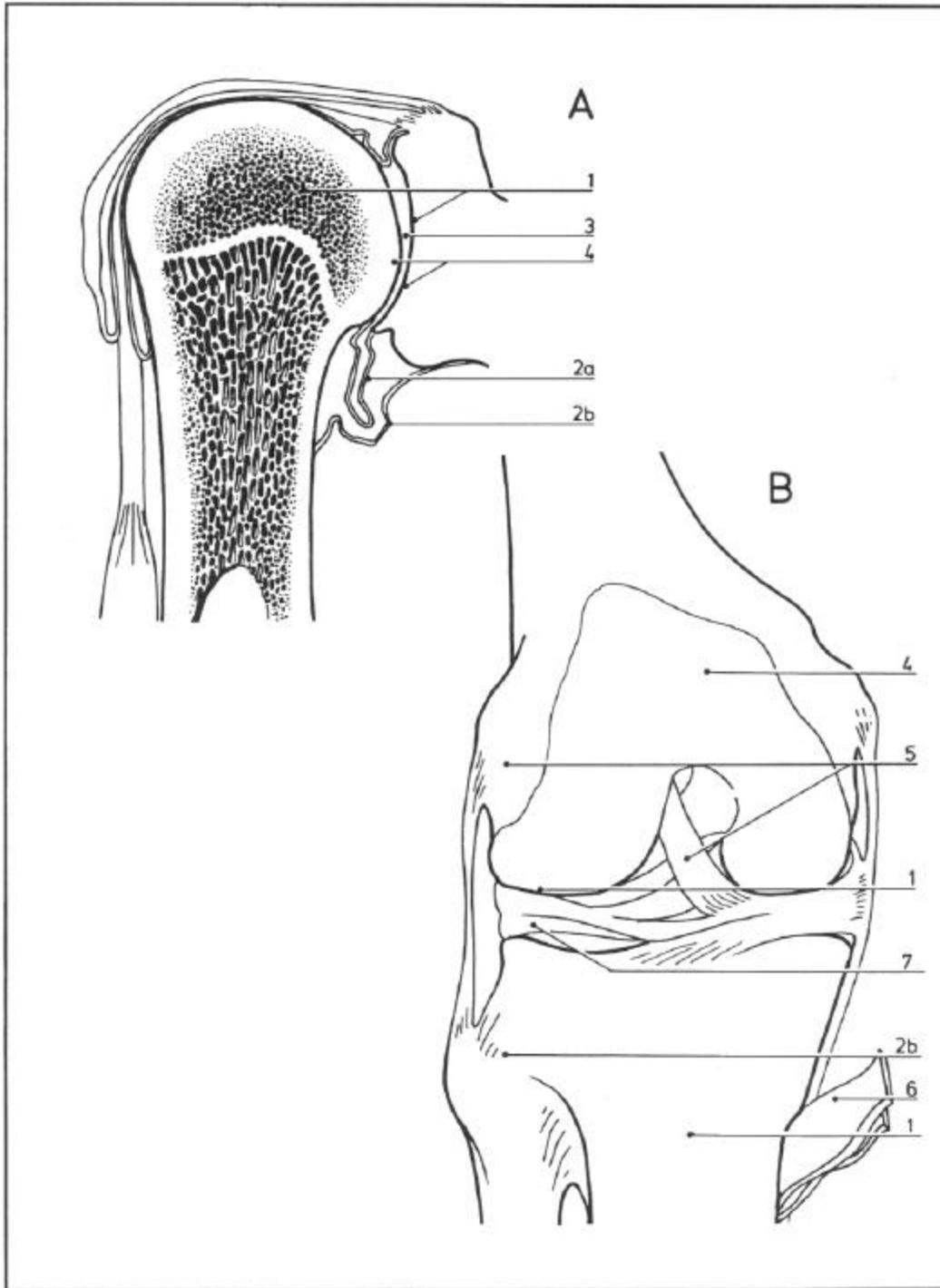
articul - joint

fibro - connective tissue

synovi - synovial fluid

5. **Arthrotome** is an instrument used to cut into a joint. An **arthroscope** is an endoscope which is used to view the interior of a joint. A **chondrectomy** would be the surgical removal of a cartilage.

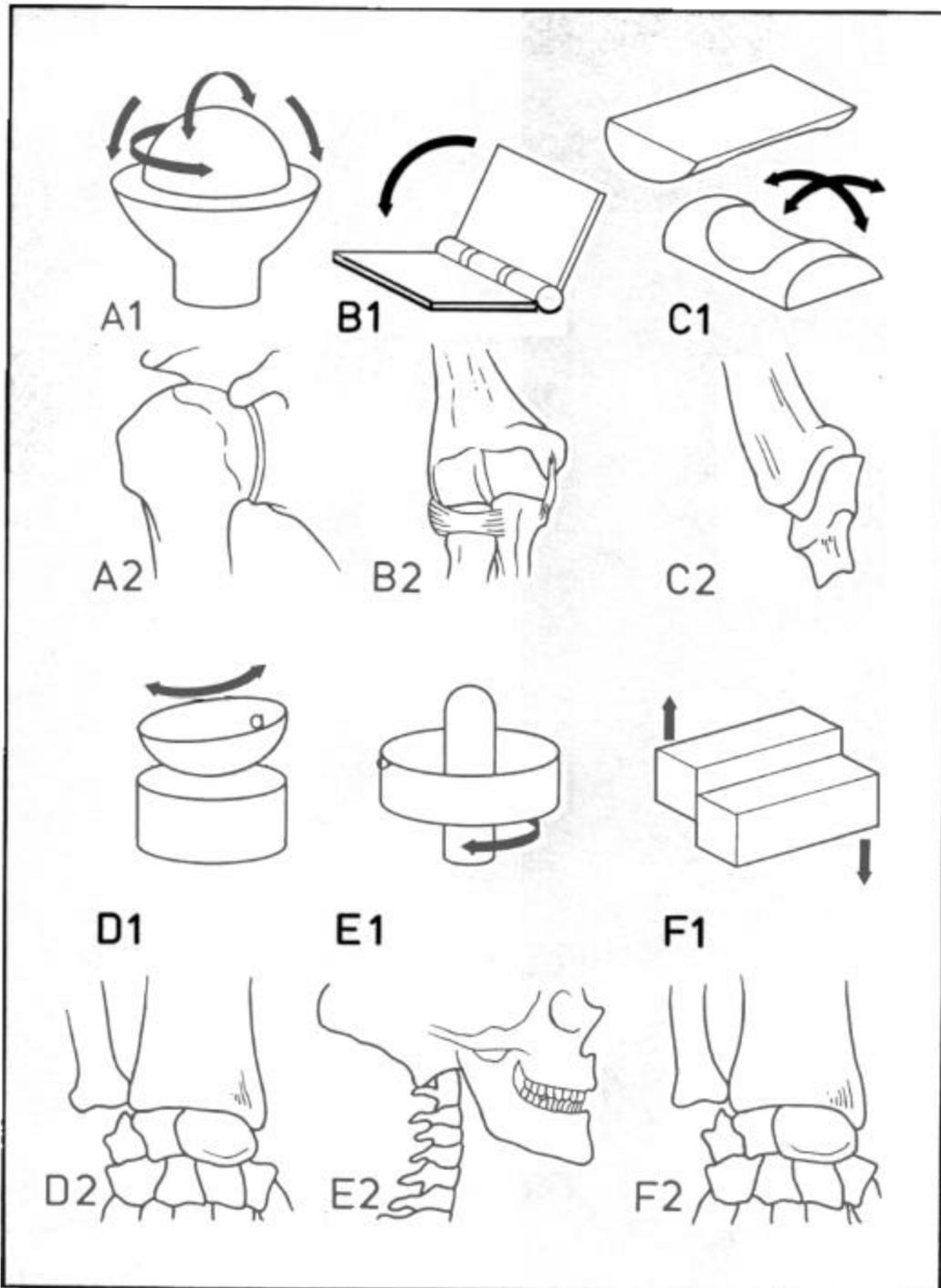
Articulating joints



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- | | |
|---|------------------------------|
| A Section through shoulder joint (ball and socket) | 4 Articular cartilage |
| | 5 Ligaments |
| B Anterior view of knee joint (hinge joint) | 6 Tendons |
| | 7 Menisci |
-
- | |
|------------------------------|
| 1 Articulating joints |
| 2 Articular capsule |
| 2a Synovial membrane |
| 2b Fibrous membrane |
| 3 Joint cavity |

Joints: types



- | | | |
|--|--|------------------------------|
| Types of synovial joint | | |
| A1 Ball-and-socket (spheroidal) joint mechanism | C2 Carpometacarpal joint of thumb | F2 Intercarpal joints |
| A2 Shoulder joint | D1 Ellipsoid joint mechanism | |
| B1 Hinge joint (ginglymus) mechanism | D2 Wrist (radiocarpal) joint | |
| B2 Elbow joint | E1 Pivot (trochoid) joint mechanism | |
| C1 Saddle (sellar) joint mechanism | E2 Median atlanto-axial joint | |
| | F1 Plane (gliding) joint | |

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MUSCULAR SYSTEM

1. The **muscular system** is made up of more than 600 muscles. This system provides for our ability to maintain our posture, produce body heat, interact with our environment through motion and movement, and operation of automatic functions of the body. There are three types of muscles: **voluntary** (or skeletal), **involuntary** (or visceral), and **cardiac** (heart).

2. The **voluntary muscles** are most generally attached to the skeletal structures and are under voluntary control. In other words, we must tell them to help us move, reach, and grasp through conscious effort. They are also called **striated** muscles because under a microscope a striped appearance is observed. Voluntary muscles are made up of bundles of muscle fibers and are attached to bones by **tendons**, which are tough, white, cords of inelastic muscle tissue. Movement occurs when these bundles contract and extend. Contraction and extension of voluntary muscles can be achieved relatively quickly; however, they tire easily. See illustrations for anatomical location of voluntary muscles of the human body.

3. **Involuntary muscles** (visceral) provide for the movement of blood throughout the vascular system. They also aid in the digestion of food. **Peristalsis** is the wavelike motion seen in the large and small intestines in order to facilitate the movement of their contents. Involuntary muscles are under the control of the **autonomic nervous system** and are not consciously controlled. These muscles are also found in the various glands of the human body, blood vessels, and the uterus. These types of muscles are made up of much smaller muscle fibers and do not appear striped under the microscope, as the voluntary muscles appear. They appear smoother under such inspection and are often referred to as **smooth muscles**.

4. The **cardiac muscle** is a unique muscle in that the muscle fibers interlace with one another and have very small amounts of connective tissue at their joining. No other muscle in the human body has this distinction. This type of muscle contracts and relaxes in a slow rhythmical action and helps produce sounds that can determine normal or abnormal functioning of the heart.

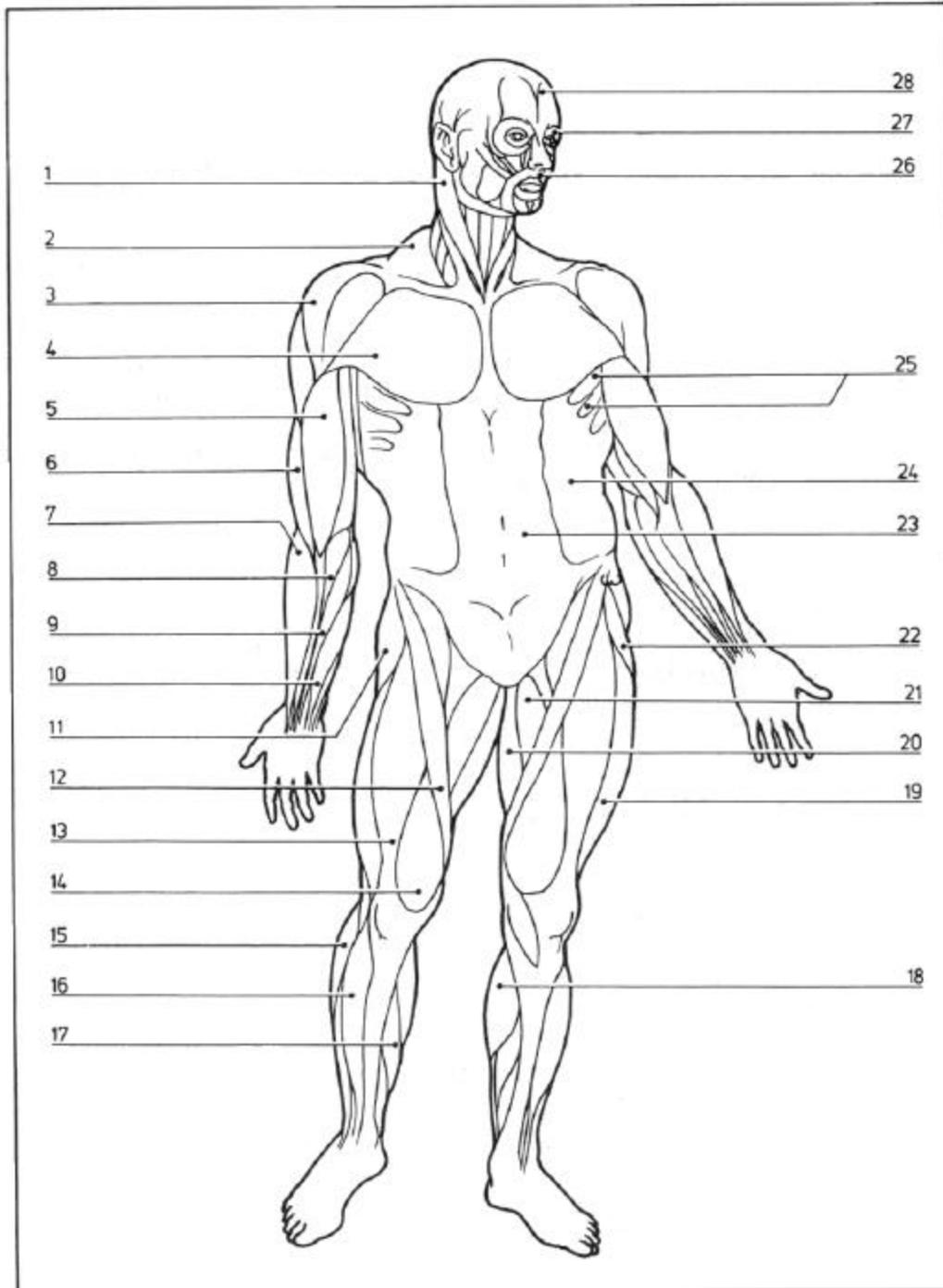
5. The following terms are used to describe the muscular system.

my - muscle

ten - tendon

6. **Myology** is the study of muscles. **Myopathy** is any disease of a muscle. **Tendonitis** is the inflammation of a tendon. A **myotome** is a surgical instrument used to cut a muscle.

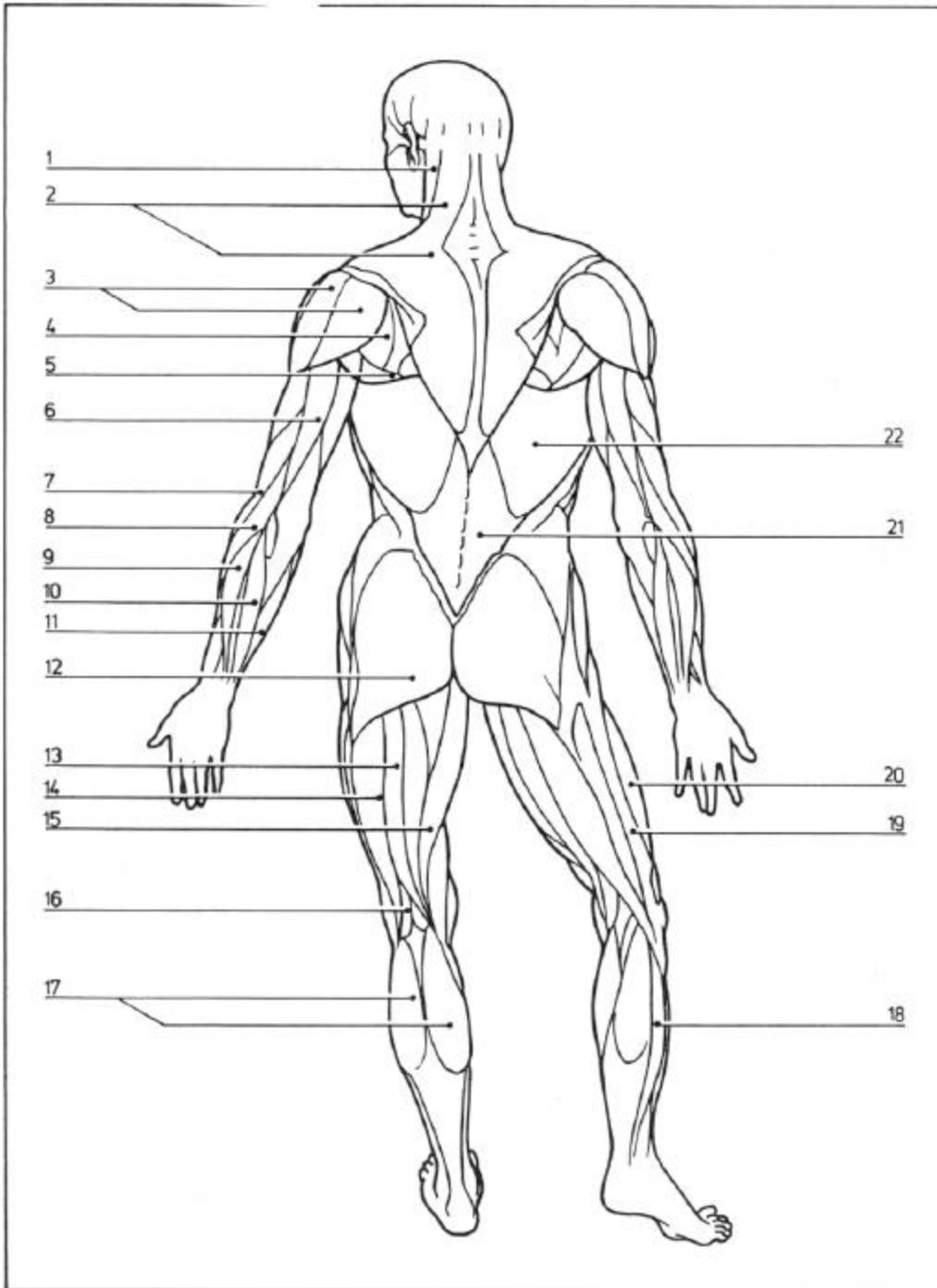
ANTERIOR VIEW OF SUPERFICIAL MUSCLES



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- | | | |
|---|--|---|
| <p>Anterior view of superficial muscles</p> <p>1 Sternocleidomastoid
 2 Trapezius
 3 Deltoid
 4 Pectoralis major
 5 Biceps brachii
 6 Brachialis
 7 Brachioradialis
 8 Flexor carpi radialis</p> | <p>9 Palmaris longus
 10 Flexor digitorum superficialis
 11 Gluteus medius
 12 Sartorius
 13 Rectus femoris
 14 Vastus medialis
 15 Peroneus longus
 16 Tibialis anterior
 17 Soleus
 18 Gastrocnemius</p> | <p>19 Vastus lateralis
 20 Gracilis
 21 Adductor longus
 22 Tensor fasciae latae
 23 Rectus abdominis
 24 External abdominal oblique
 25 Serratus anterior
 26 Orbicularis oris
 27 Orbicularis oculi
 28 Occipitofrontalis</p> |
|---|--|---|

POSTERIOR VIEW OF SUPERFICIAL MUSCLES



Posterior view of superficial muscles

- 1 Sternocleidomastoid
- 2 Trapezius
- 3 Deltoid
- 4 Infraspinatus
- 5 Teres major
- 6 Triceps brachii
- 7 Brachioradialis
- 8 Extensor carpi radialis

- 9 Extensor digitorum
- 10 Extensor digiti minimi
- 11 Extensor carpi ulnaris
- 12 Gluteus maximus
- 13 Biceps femoris
- 14 Semitendinosus
- 15 Gracilis
- 16 Semimembranosus
- 17 Gastrocnemius
- 18 Soleus
- 19 Fascia lata

- 20 Vastus lateralis
- 21 Thoracolumbar fascia
- 22 Latissimus dorsi

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NERVOUS SYSTEM

1. The nervous system consists of the **central nervous system**, the brain and the spinal cord, the **peripheral nervous system**, the nerve fibers, ganglia, and end organs (in other words, the nervous system outside of the brain and spinal cord), and the **sensory organs**, eyes, ears, nose, and tongue.
2. The nervous systems are only separated anatomically, they actually interact and intertwine so that we can communicate within ourselves and with our environment. The nervous system is, however, separated functionally into two systems: the **involuntary** (autonomic), which is unconsciously controlled, and the **voluntary**, which is controlled by conscious thought.
3. **Nerve cells** or **neurons** connect all parts of the human body in order to receive, process, and send messages. The nerve cell has three parts: **the body**, which is the nerve cell; the **dendrite**, which resembles tree branches and is responsible for receiving incoming messages, and **the axon**, which is generally not branch-like but a single extension that transmits messages to the next neuron.
4. There are basically three groups of neurons. One group acts as **sensory** nerve cells and tells the body that pain is present in our hand. Another group acts as **motor** nerve cells and tells the body to respond to the pain by contracting a muscle to move our hand from the source of pain. The third group can carry both **sensory** and **motor impulses**.
5. The brain is the command center for the central nervous system; without its interaction the human body is considered clinically dead. The **medulla oblongata**, which is located at the base of the brain, controls our heartbeat, respiration, and body temperature. The **cerebellum**, which is located at the back of the brain behind the medulla oblongata, controls equilibrium, body balance, and muscle coordination. The **cerebrum**, which is located above the cerebellum in the back of the brain, is the largest part and controls our memory and thought processes, our voluntary impulses (decisions and movements), and interpretation of all sensory nerve impulses (information).
6. The **spinal cord** connects the brain to the peripheral nervous system (all other parts of the body). It consists of a large bundle of neurons, which branch off into **ganglia**, which in turn are the beginning of the peripheral nervous system. The peripheral nervous system extends out to all other parts of the body where it picks up stimuli and returns it to the spinal cord and brain for interpretation and response messages. See illustration for the nervous system.

7. The **sensory nerves** of the peripheral nervous system are divided into two groups. One group consists of the sensory nerves of the **special senses**, which are **sight, sound, smell, and taste**. The other group consists of nerve endings, which give us the sensation of heat, cold, touch, pain, and pressure. This chapter will only discuss the organs of the special senses.

8. The **eye** is the globular organ of vision (sight). The eye has three layers called the **sclera, choroid, and the retina**. See the illustration for a diagram of the eye. The **sclera** is the white, dense, inelastic membrane that helps the eye maintain its globular shape and provides protection. The **choroid** is the thin, dark brown middle layer. The **rods and cones** within the retina receive the light impressions which enter the eye through the pupil. The **pupil**, which is surrounded by a colored ring called the **iris**, dilates and constricts (by involuntary muscles) to control the amount of light which is reflected onto the retina by lens. The rods and cones then transmit the impressions by way of the optic nerves to the brain where they are interpreted.

9. The **ear** is the sensory organ of hearing and equilibrium. See the illustration for a diagram of the ear. The ear is divided into three parts: **outer ear, middle ear, and inner ear**. The **outer ear** protrudes from the sides of the head and collects sound waves which it directs to the ear drum. The ear drum then conducts the sound waves to the middle ear. Within the **middle ear** are three tiny, connected bones called the hammer, the anvil, and the stirrup. After receiving the sound waves, these tiny bones conduct (by vibrating) the sound waves into the inner ear. The **inner ear** contains the sensory nerves and as sound waves enter, they are converted into nerve impulses and are conducted to the brain for interpretation by the auditory nerves. The eustachian tube, which is located in the middle ear, connects the middle ear to the pharynx. This tube helps to equalize pressure on both sides of the ear drum.

10. The organ of smell is the **nose**. The sensory nerve cells for smell are located in the mucous membrane that lines the upper portion of the nasal cavity. As smells pass through the nasal cavity, they are transmitted to the brain by the olfactory sensory nerve.

11. The **tongue** is the sensory organ of taste. Tiny buds cover the surface of the tongue and they are capable of distinguishing four kinds of taste: sweet, sour, bitter, and salty. The **taste receptors** (buds) are constantly being replaced by new cells.

11. The following terms are used to describe the nervous system:

encephalo - brain

myel - spine

mening - membrane

gloss - tongue

neuro - nerve

naso - nose

sens - sensory

ocul - eye

spina - spinal cord

ophthalm - eye

ot - ear

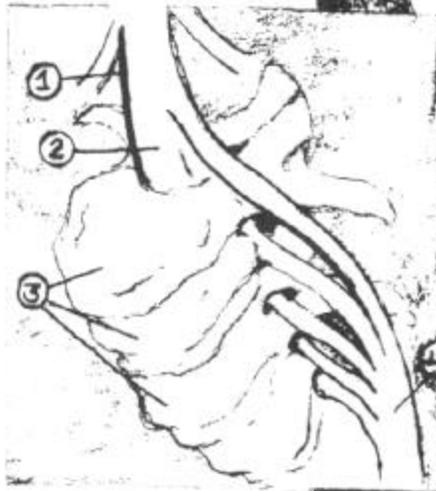
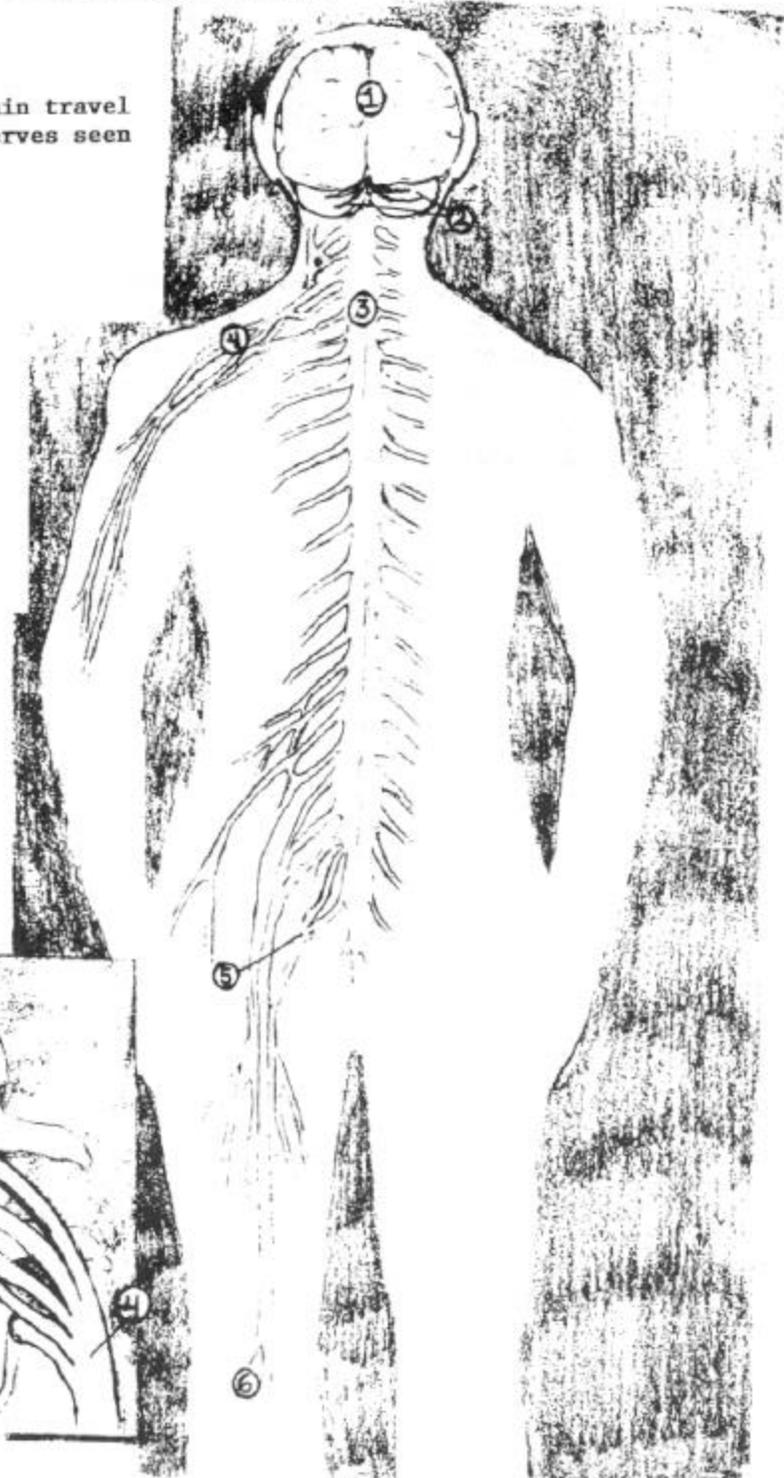
rhin - nose

12. **Spinal meningitis** is an inflammation of the membranes covering the spinal cord. **Neuritis** is the inflammation of a neuron/nerve. When an **EEG** is ordered for a patient, a test using an electroencephalograph records the electrical activity of the brain. A **myelogram tray** contains instruments and supplies used for a diagnostic photograph of the spinal cord by introducing a contrast medium (radiopaque dye). **Ophthalmoscopes** and **otoscopes** are instruments used to view the eyes, ears, and nose. A **rhinoplasty tray** contains surgical instruments used in nasal surgery.

CENTRAL NERVOUS SYSTEM

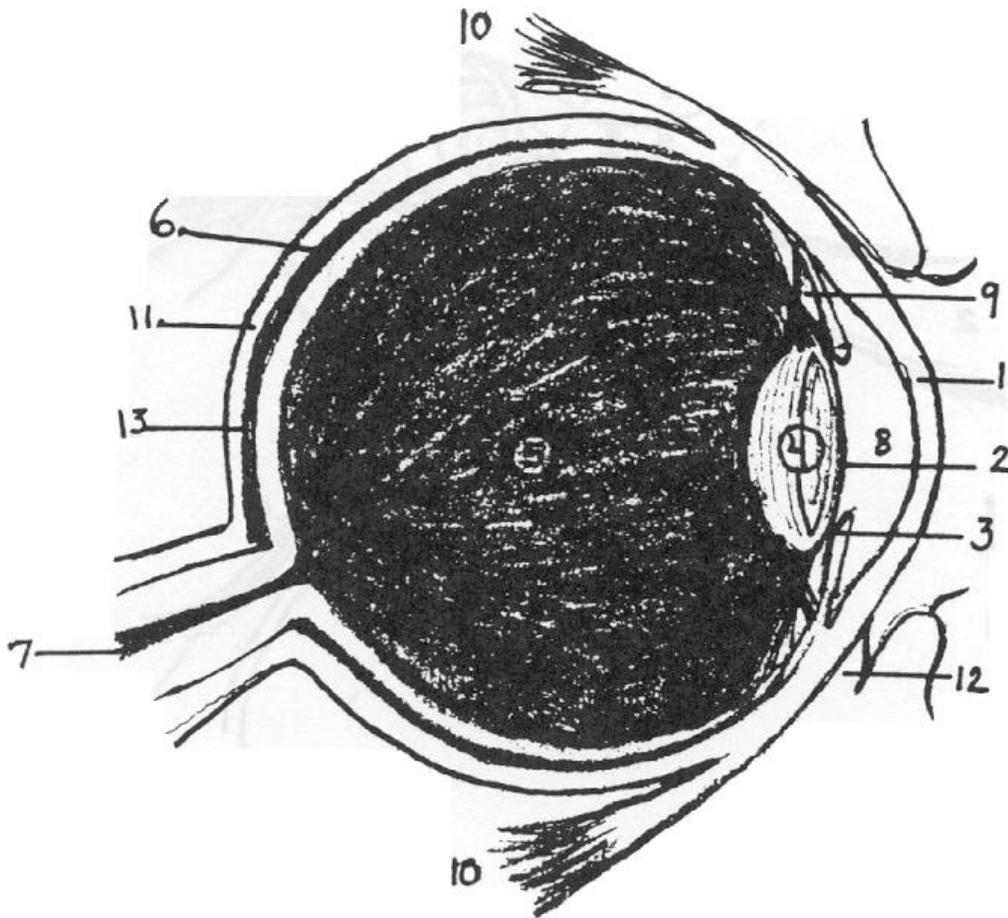
Messages to and from the brain travel along the spinal cord and nerves seen branching off the cord.

1. Cerebrum
2. Cerebellum
3. Spinal cord
4. Brachial plexus
5. Sacral plexus
6. Peripheral nerve



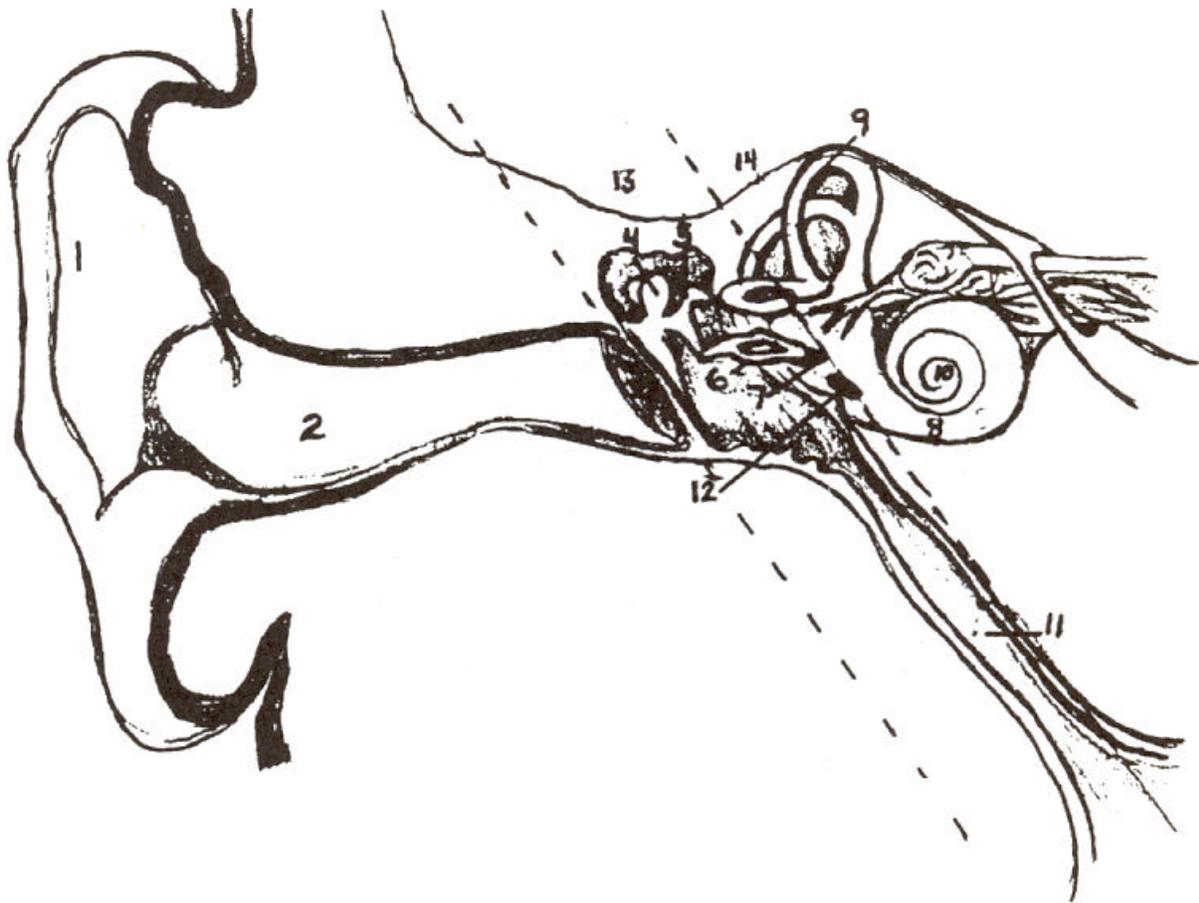
Section of Vertebral Column
(upper vertebrae have been removed
to show location of the spinal cord
within the canal.)

1. Meninges
2. Spinal cord
3. Vertebrae



STRUCTURE OF THE EYE

- | | |
|---------------------|----------------------|
| 1. Cornea | 8. Anterior chamber |
| 2. Pupil | 9. Posterior chamber |
| 3. Iris | 10. Muscle |
| 4. Crystalline lens | 11. Sclera |
| 5. Vitreous body | 12. Conjunctiva |
| 6. Retina | 13. Choroid |
| 7. Optic nerve | |



STRUCTURE OF THE EAR

- | | |
|---------------------------------|------------------------|
| 1. External ear (pinna) | 8. Vestibule |
| 2. External auditory canal | 9. Semicircular canals |
| 3. Tympanic membrand (ear drum) | 10. Cochlea |
| 4. Malleus | 11. Eustachian tube |
| 5. Incus | 12. Round window |
| 6. Stapes | 13. Middle ear |
| 7. Oval window | 14. Inner ear |

VASCULAR SYSTEM (CIRCULATORY)

1. The vascular or circulatory system is made up of two parts, the **blood vascular** and the **lymphatic systems**. The **blood vascular system** consists of the **heart, arteries, arterioles, capillaries, venules, veins, and blood**. This system is responsible for transporting oxygen, nutrients, minerals, chemicals, disease fighting cells, and hormones to all parts of the body. This same system is responsible for removing waste products and carbon dioxide from all parts of the body. The circulatory system allows us to maintain **hemostasis** (internal stability) by regulating body temperature and electrolyte balance. The **lymphatic system** consists of thin walled capillaries, larger lymphatic vessels, firm, rounded bodies which are called **lymph nodes**, and **lymphatic organs** that resemble lymph nodes, such as the **spleen, tonsils, thymus**, areas of the **alimentary system** (digestive system), and **bone marrow**. The lymphatic system helps remove foreign material and plays an important part in the body's immunologic protection.

2. The **heart** is a four-chambered muscular pump which facilitates the circulation of blood. See the illustration for a diagram of the blood flow through the heart. The four chambers are: the **right atrium**, the **right ventricle**, the **left atrium**, and the **left ventricle**. These chambers contract in pairs, the atriums contract first and then the ventricles. Even though the contractions are the force that pumps the blood through the heart, the actual "lub, dub" sound, which is heard, is caused by the valves between the atriums and the ventricles opening and closing. The **right atrium** receives blood from the upper part of the body through the **superior vena cava** and the **inferior vena cava** delivers the blood from the lower part of the body. The blood is then pumped from the right atrium to the **right ventricle**. From the right atrium blood is then pumped through the **pulmonary arteries** to the **lungs**. The blood is **oxygenated** (oxygen is added to the blood cells) in the lungs and is then pumped into the **pulmonary veins** which carry the blood back to the heart's **left atrium**. The pulmonary arteries and veins are unique in the fact that the pulmonary arteries are the only arteries in the body that carry **unoxygenated** (oxygen has been removed from the blood cells by the tissues) blood and the pulmonary veins are the only veins in the body that carry oxygenated blood (arteries and veins will be discussed later in this section). The blood is then pumped from the left atrium to the **left ventricle**. The left ventricle then pumps the blood out of the heart into the **aorta** (the largest artery of the human body) where the blood is pumped to all other parts of the body. **Arteries** carry oxygenated blood (except for the pulmonary artery) to the tissues of the body. Arteries branch off into **arterioles**, which further branch off into **capillaries** and it is at the capillaries where nutrients, oxygen, and other products are absorbed for use by the body's tissues. **Veins** carry deoxygenated blood back from the tissues. Waste products are removed from the tissues by **venules**, which are branches of the veins. The veins carry deoxygenated blood back to the heart and the process starts all over. In 24 hours, 7,200 quarts of

blood pass through the heart. There are approximately 5 quarts of blood, recycled through the heart once every minute, in the average adult body. See the illustration for a diagram of arteries and veins of the human body.

3. **Blood** is the fluid that is circulated through the heart, arteries, capillaries, and veins. Blood carries nutrients and oxygen to the body's cells. It consists of **plasma** -- a pale yellow liquid, **erythrocytes** -- or red blood cells, **leukocytes** -- or white blood cells, and **thrombocytes** or platelets. **Erythrocytes** (red blood cells) are small disk-shaped blood cells that are saturated with **hemoglobin**. When blood is pumped through the lungs, oxygen attaches itself to the hemoglobin and the hemoglobin carries it to the body's cells. **Leukocytes** (white blood cells) are of various sizes and in less number than erythrocytes and are mainly concerned with destroying pathogenic (disease producing) organisms. Thrombocytes/platelets aid in the clotting of blood. Their irregular shape also aids in the clotting process.

4. Blood is an essential need of the human body. The brain's requirement is constant; however, other systems may need more or less at any given time. For example, after you have eaten a meal, the stomach requires an extra supply in order to facilitate digestion and absorption of nutrients. During physical exercise, the muscular system requires larger amounts in order to perform and remove waste products produced by strenuous activity. The venous system relies on activities of daily living to facilitate pushing blood back to the heart. The simple act of walking causes muscles in the legs to contract and extend which helps squeeze and push blood along the veins. Thigh-length and knee-length compression devices are used in hospitals on bed ridden patients in order to prevent **venous stasis** (pooling of blood in the extremities). This device is used to push the blood back up towards the heart and prevent blood clots, which could lead to **thrombophlebitis** (inflammation of a vein caused by a blood clot) or even more serious complications, such as death, due to a blood clot that has become mobile and occludes (completely blocks the passage of a vessel so that blood is unable to feed the heart muscle) a vessel in the heart, causing a heart attack.

5. The **lymphatic system** drains excess fluids away from the tissues, transports dead blood cells and waste products away from the tissues, and functions as another line of defense against pathogens. The lymphatic vessels carry **lymph** -- a clear, watery fluid containing **lymphocytes**. **Lymphocytes** are cells that eat up disease producing cells. The **lymph nodes** are located throughout the body along the lymph vessels. These nodes are largely responsible for our disease fighting processes. Lymphocytes are concentrated in the lymph nodes and, as the fluid passes through the nodes, it is filtered and recycled and then directed back to the vascular system for recirculation throughout the body for reuse.

6. The **spleen, tonsils, lymph nodes, and parts of the digestive tract** act as **secondary lymphoid organs** in that they filter and fight pathogens. The **primary lymphoid organs** are the thymus and bone marrow. These organs are responsible for making the lymphocytes that help the human body fight disease and produce antibodies.

7. The following terms are used to describe the vascular system:

angi - vessel

arteri - artery

cardi - heart

cyt - cell

erythr - red

hemat - blood

hem - blood

leuk - white

lymph - water (lymphatic)

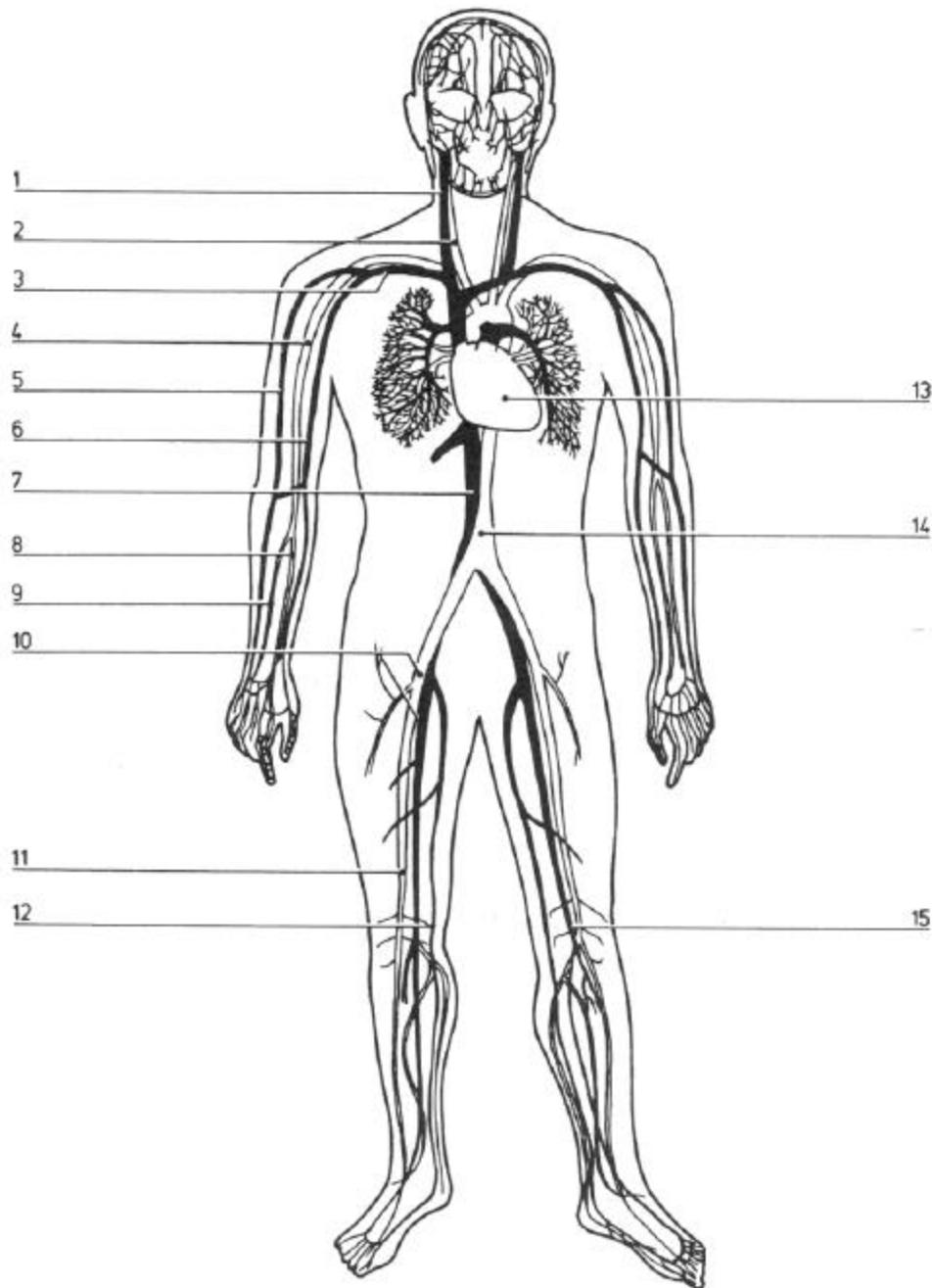
phleb - vein

vas - vessel

em - blood

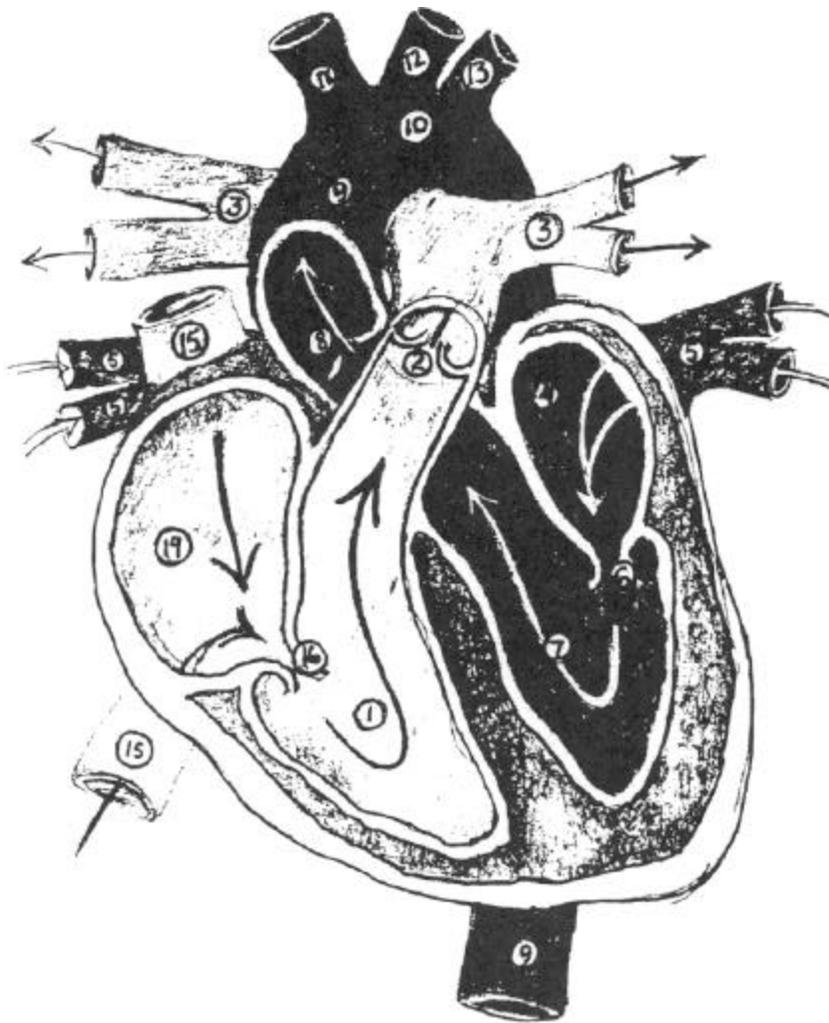
8. **Arteriosclerosis** is a disease where the walls of arteries become thick and lose their elasticity. Cardiology is the study of the heart. **Phlebitis** is the inflammation of a vein. A **hemostat** is a clamp used for preventing bleeding from vessels during surgery.

Key diagram



Anterior view showing major arteries (white) and veins (black)

- | | | | |
|---|----------------------------|----|------------------------------|
| 1 | Internal jugular vein | 6 | Basilic vein |
| 2 | Common carotid artery | 7 | Inferior vena cava |
| 3 | Subclavian vein and artery | 8 | Radial artery |
| 4 | Brachial artery | 9 | Ulnar artery |
| 5 | Cephalic vein | 10 | Common iliac artery and vein |
| | | 11 | Femoral artery |
| | | 12 | Great saphenous vein |
| | | 13 | Heart |
| | | 14 | Aorta |
| | | 15 | Femoral vein |



BLOOD FLOW THROUGH THE HEART

- | | |
|-------------------------------------|--------------------------------------|
| 1. Right ventricle | 9. Aorta |
| 2. Pulmonary valve | 10. Aortic arch |
| 3. Pulmonary artery, right and left | 11. Innominate artery |
| 4. Left atrium | 12. Common carotid artery |
| 5. Pulmonary veins, right and left | 13. Subclavian artery |
| 6. Mitral (bicuspid) valve | 14. Right atrium |
| 7. Left ventricle | 15. Vena cava, inferior and superior |
| 8. Aortic valve | 16. Tricuspid valve |

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RESPIRATORY SYSTEM

1. The **respiratory system** is responsible for supplying life sustaining oxygen which the body requires to produce energy and remove the waste product, carbon dioxide, which is given off when oxygen is released to the cells. Breathing consists of two phases: **inspiration** and **expiration**. **Inspiration**, or **inhalation**, is the process of drawing air into the lungs. **Expiration** is the process of pushing air out of the lungs. This process is called **ventilation**.

2. The organs of the respiratory system are the **nostrils** (nose), **pharynx**, **larynx** (voice box), **trachea** (windpipe), **bronchi**, and the **lungs**. See the illustration for a diagram of the respiratory system.

3. When air is taken into the lungs (inspiration), it first passes through the **nostrils**, where it is warmed, moistened, and filtered. It then proceeds through the **pharynx**, **larynx**, and **trachea**. The trachea then branches to form the **left and right main stem bronchi**. The bronchi keep dividing many times so that it resembles the branches of a tree. These branches are called **bronchioles** and they end in tiny air sacs called **alveoli**. These clusters of tiny air sacs are where respiration actually takes place. **Respiration** is the process by which oxygen and carbon dioxide are exchanged at the cellular level. The alveoli contain capillaries and these structures are surrounded by very thin membranes which make the exchange of oxygen and carbon dioxide in the blood easier. After the exchange, carbon dioxide is then exhaled by the process of expiration and exhaled back out the way oxygen was brought in. Oxygenated blood is then circulated throughout the vascular system.

4. The following terms are used to describe the vascular system:

aer - air bronchi - windpipe

cyan - blue nas - nose

pleur - rib, side thorac - chest

pne - breathing pneum - breath, air

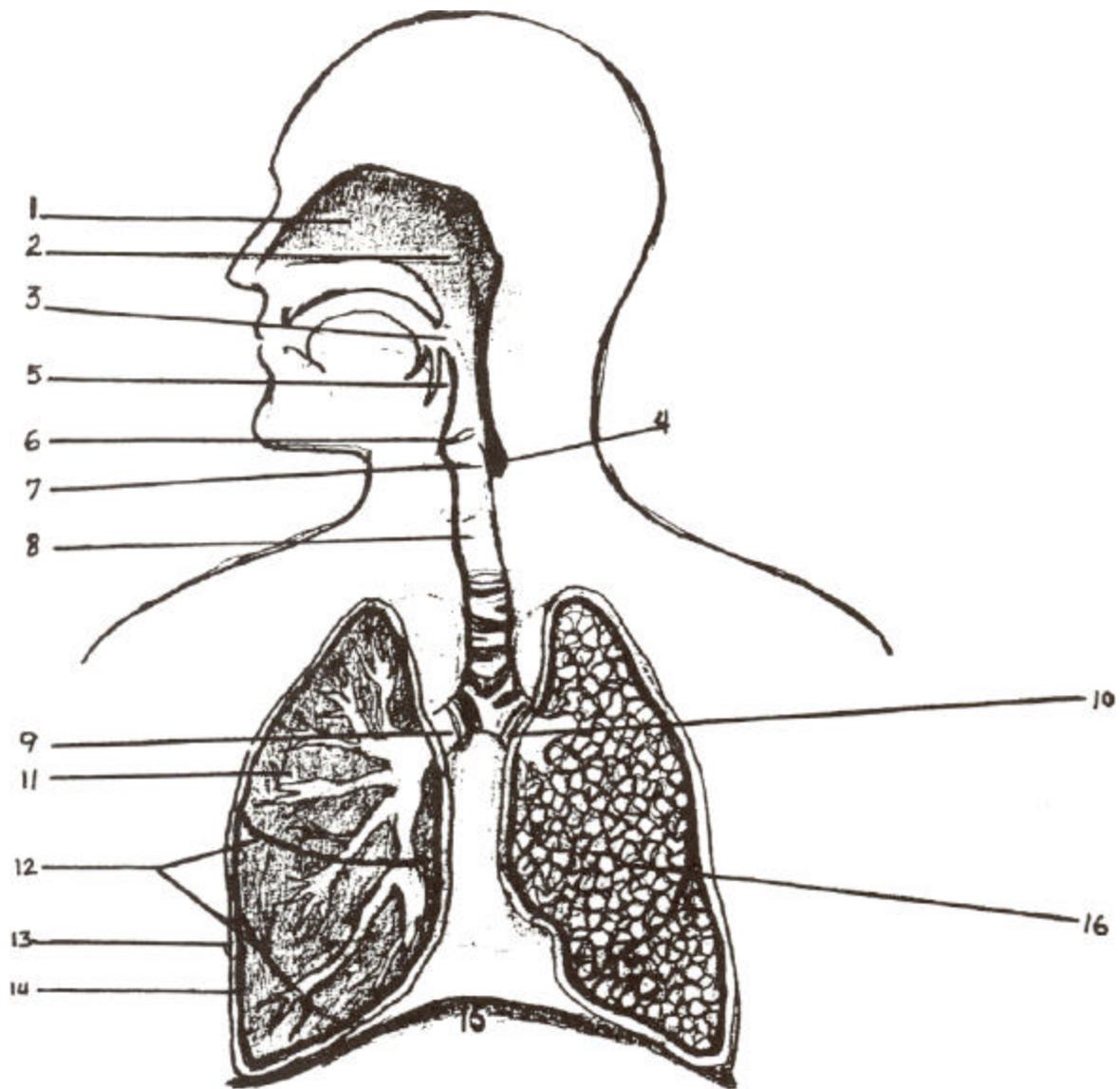
pneumo - lung pulmo - lung

rhin - nose sin - sinus (fold, hollow)

trache - windpipe (trachea) spir - breathing

5. A **pneumothorax** is a collapsed lung. When a patient is said to be cyanotic (blue) they are oxygen deprived. A **rhinoplasty tray** is a surgical tray containing instruments

for a surgical operation on the nose. **Pneumonia** is an inflammation of the lungs. A **thoracotomy tray** contains instruments used in making a surgical incision into the chest wall.



RESPIRATORY SYSTEM

- | | |
|-----------------|--|
| 1. Nasal cavity | 9. Right main stem bronchus |
| 2. Nasopharynx | 10. Left main stem bronchus |
| 3. Pharynx | 11. Right lung (lobar and segmental bronchi exposed) |
| 4. Esophagus | 12. Lobe divisions |
| 5. Epiglottis | 13. Parietal pleura |
| 6. Vocal cords | 14. Visceral pleura |
| 7. Larynx | 15. Diaphragm |
| 8. Trachea | 16. Left lung |

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UROGENITAL SYSTEM

1. The **urinary** and **genital systems** are so closely related they are usually grouped together as the **urogenital system**. In both males and females, the urinary (renal) system is responsible for the formation and elimination of urine, and the genital system is responsible for producing hormones which influence the development of feminine and masculine characteristics and human reproduction.
2. The **urinary system** or **renal system** (renal means kidneys or pertaining to the kidneys) is responsible for filtering waste products for the blood and eliminating them from the body. It consists of the **kidneys, ureters, bladder, and urethra**. See the illustration for a diagram of the urinary system. The **kidneys** are where urine is formed. They are two bean-shaped organs located in the back upper left and right quadrants of the abdominal cavity. The blood vessels are filtered through **nephrons** (tiny filtering units of the kidney of which there are many), and the waste liquids and other particles removed are what make up urine. The **ureters** are thick walled tubes that connect each kidney to the urinary bladder. These tubes can be up to 10-15 inches long and, if they become blocked (such as with a kidney stone or other renal diseases), the kidneys will continue to produce urine and eventually the kidney is destroyed. As with the liver, the human body must have at least one functioning kidney to maintain life. The loss of both kidneys requires artificial removal of waste products called **hemodialysis**. During hemodialysis, blood is filtered through a machine which acts like a kidney and removes harmful wastes. Human kidney transplants have also been successful and are a welcomed relief from having to stay on a dialysis machine up to 3 days per week and 4 hours each treatment.
3. The ureters empty urine into the bladder which is an extremely muscular sac. The bladder normally rests in the pelvic cavity but, as it fills with urine, it can rise up into the abdominal cavity. The bladder stores the urine until it is eliminated outside of the body by the **urethra**.
4. The kidneys are not only responsible for forming and removing urine but are also helpful in reabsorbing water, salts, sugar, and protein from the blood. This process enables the body to maintain homeostasis by controlling the acid-base balance of the blood and maintaining adequate levels of water, salts, proteins, and electrolytes (such as potassium).
5. The human body excretes about **one and one-half quarts** of urine daily. The kidneys can filter **one quart** of blood per minute or **360 gallons per day**.
6. The **genital system** in the female is comprised of the **ovaries, fallopian tubes, uterus, vagina (birth canal), and mammary glands**. See the illustrations for diagrams of the female and male genital systems. The **ovaries** are almond-shaped organs that produce **ova** (eggs) that contain the female genes. They also produce the female

hormones estrogen and progesterone, which regulate the menstrual cycle and produce the development of secondary feminine characteristics. The **fallopian tubes** connect the ovaries to the uterus and are how the ova (egg) travels to the uterus after being fertilized. The **uterus** is a large muscular organ where the fertilized ova develops into a fetus. The uterus nourishes and holds the fetus during pregnancy. The **vagina** is the canal that extends from the uterus (the cervix is the lower portion of the uterus to which the vagina extends from) to the exterior of the body. The **mammary glands** (breasts), under hormonal control, fill with milk after child birth. Breast milk is nutritious, easily digested, and contains the mother's antibodies which will nourish and protect the child from diseases.

7. The male genital system consists of the **testes** (testicles), **penis**, and **prostate gland**. The **testes** produce sperm (spermatozoa) which carry the male genes. They also produce testosterone, the male hormone responsible for secondary male characteristics such as body hair. The **penis** is the external appendage used for urination and sexual intercourse. The **prostate gland** is the male organ responsible for secreting a liquid alkaline substance which allows for the mobility of the sperm. The fluid also protects the sperm from the acidic conditions of the female vagina.

8. **Human reproduction** begins when a sperm from the male penetrates the female ova (egg). This process is known as **fertilization** and it takes place in the fallopian tubes of the female. After the egg is fertilized by the sperm, it then travels to the uterus where it attaches itself to the uterine wall. The ovaries then secrete hormones which tell the body to protect and nourish the developing fetus and prepare the body for the birth process. When labor begins, the cervix of the uterus dilates (opens) to allow the baby to be pushed through the birth canal (vagina) and delivered. This seems like a simple process, yet human reproduction is an amazing intricate and delicate process and it is a wonder that reproduction takes place at all.

9. The following terms are used to describe the urogenital system:

andr - man

lact- milk

blast - bud, child

mamm - breast

bry - be full of life

mast - breast

colp - vagina

metr - womb

galact - milk

oo - egg (ovary)

gest - bear, carry

orchi - testicle

gyn - women

ov - egg

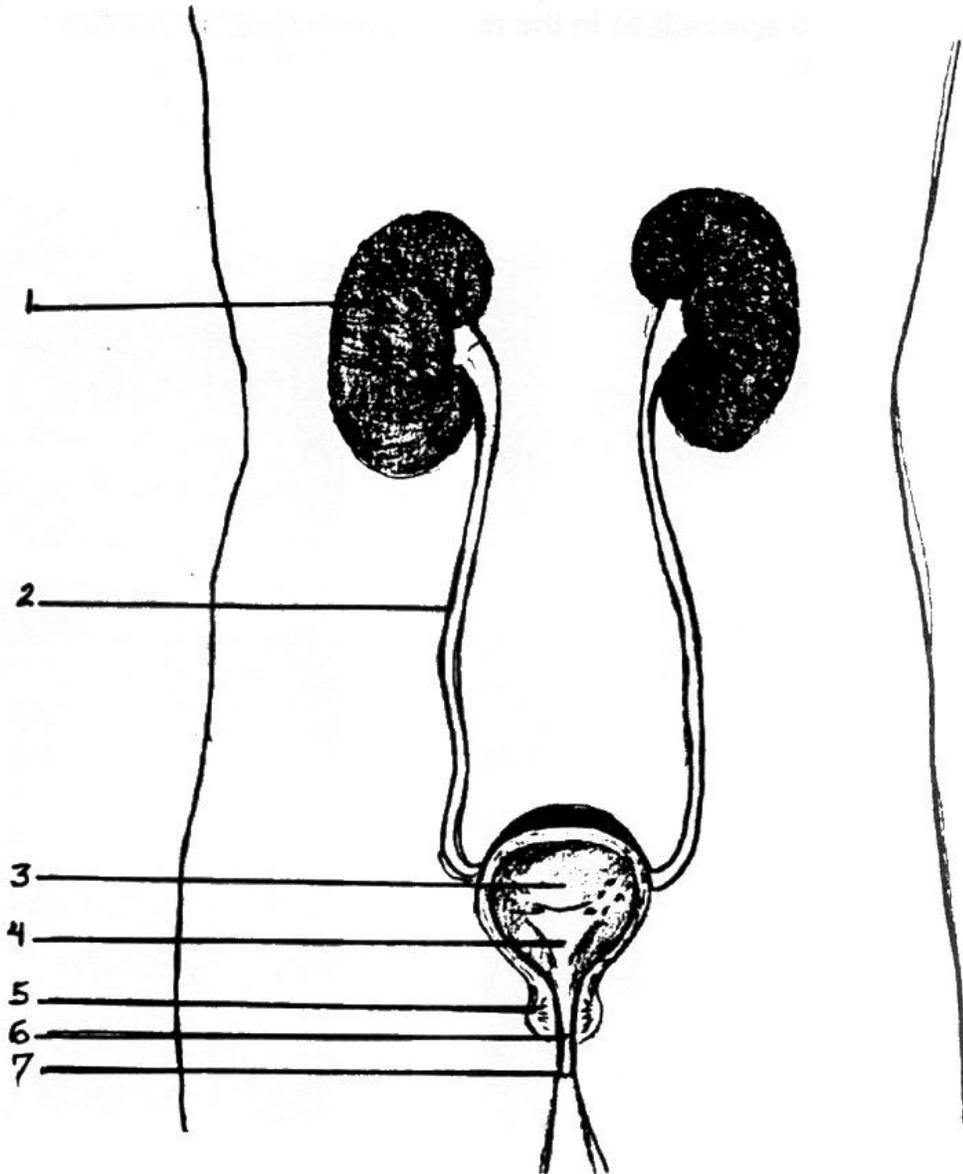
hyster - womb

salping - tube

sperm - seed

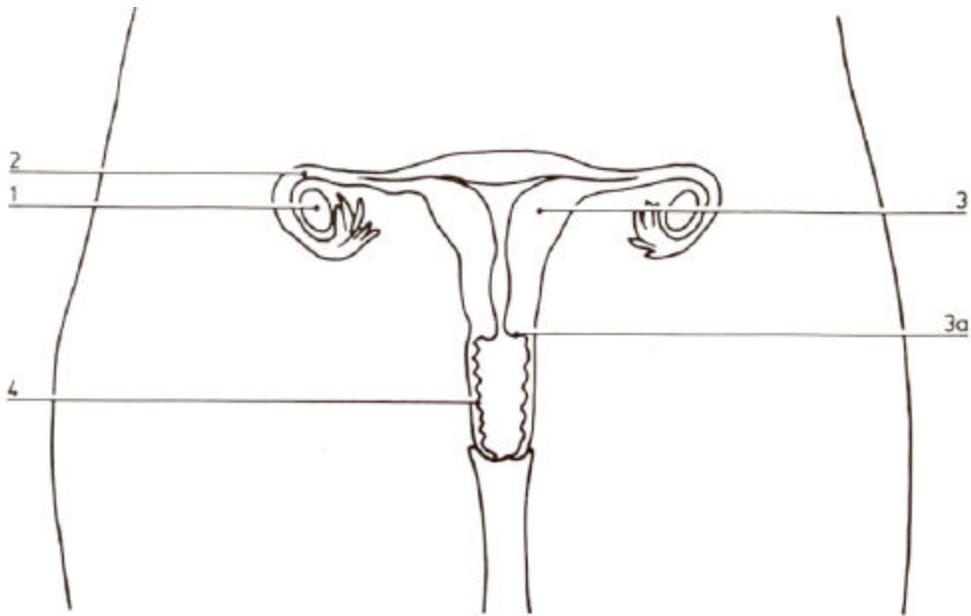
test - testicle

10. A **hysterectomy** is the surgical removal of the uterus. An **orchietomy** is the surgical removal of a testicle. A **mammogram** is an x-ray of the breasts to detect the presence of cancer. A **prostatectomy** is the surgical removal of the prostate gland. A **gynecologist** is a physician who specializes in the reproductive system and the diseases associated with women.

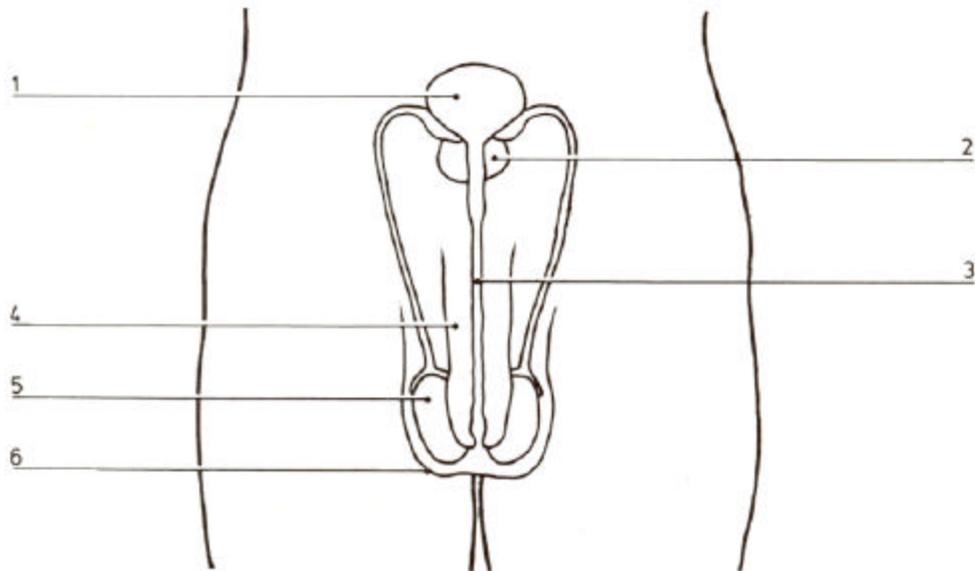


URINARY SYSTEM

- | | |
|----------------------|---------------------------|
| 1. Right kidney | 4. Trigone of the bladder |
| 2. Left ureter | 5. Prostate (male) |
| 3. Bladder | 6. Urethra |
| 7. Meatus of urethra | |



- 1 Ovary
 2 Fallopian tube
 3 Uterus
 3a Cervix
- 4 Vagina
- Anterior view of the female genital system**



Anterior view of the male genital system

- | | |
|-------------|------------|
| 1. Bladder | 4. Penis |
| 2. Prostate | 5. Testes |
| 3. Urethra | 6. Scrotum |

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ALIMENTARY SYSTEM

1. The **alimentary** (digestive) **system** is responsible for the digestion of food. The process involves the breaking down of large, complex compounds into simple ones that are easily absorbed into the blood stream for use by the body's cells. The main functions of the alimentary system are to take in nutrients and eliminate wastes.
2. The alimentary system consists of the **alimentary canal** which, for general purposes, is a tube about 30 feet long and runs from the mouth to the anus, and accessory organs which empty their contents into the alimentary canal. The alimentary canal is comprised of the **mouth, esophagus, stomach, small intestine, large intestine, rectum, and anus**. The accessory organs are the **salivary glands, liver and biliary tract, and the pancreas**. See the illustration for a diagram of the digestive system.
3. The digestive process begins even before you take in food. The sight and smell of food will trigger the central nervous system to instruct the accessory organs to prepare the canal for food intake. The salivary gland, stomach, and pancreas start to secrete a watery solution in order to aid in the process of digestion. These secretions help to make the food easier to chew, swallow, and digest. They also aid in the protection of the canal from trauma by lubricating the lining of the canal. The accessory glands also secrete enzymes which aid in the breakdown of the large compounds into smaller ones so that they can be readily absorbed into the bloodstream.
4. Food is first taken into the canal through the **mouth**. In the mouth, food is mixed with saliva which is secreted by the salivary glands, chewed, and swallowed. The contents are then passed through the esophagus into the stomach, a large muscular organ, which mixes the food with the secretions from the gastric glands and converts the contents into a semiliquid called **chyme**. The chyme then leaves the stomach and enters the small intestine. In the small intestine, chyme is then mixed with the secretions from the liver and biliary tract and the pancreas. This mixing breaks down the chyme into absorbable compounds which are readily taken into the bloodstream. In the small intestine **bile** is secreted by the liver and biliary tract. The gall bladder stores bile until it is needed for digestion. Bile is required for the breakdown of fats into simpler compounds. The **liver**, which is vital to the alimentary canal for secreting bile, has other life sustaining responsibilities. This organ (liver) is responsible for purifying blood by removing and breaking down chemicals that could be harmful to our bodies.
5. Almost all the organs which make up the alimentary canal can be bypassed or removed, and life can still be maintained by use of **feeding tubes** by which nutrients can be delivered either through the nose/mouth or directly into the stomach or small intestine. Administration of insulin and synthetic pancreatic enzymes can replace the loss of function of the pancreas. The liver's function cannot be replaced synthetically

and, without the liver, life cannot be sustained. Liver transplants, fortunately, have made it possible for individuals with liver disease to lead a normal life.

6. The **small intestine** is divided into three parts: the **duodenum**, **jejunum**, and the **ileum**. It is the longest segment of the alimentary canal, averaging about 23 feet long. Most all of the absorption of nutrients and water takes place in the small intestine. Contents that are not absorbed in the small intestine are then emptied into the large intestine. The large intestine consists of five portions: the **ascending colon**, **transverse colon**, **descending colon**, **sigmoid colon**, **rectum**, and **anus**. As the contents move through the large intestine more water is absorbed into the bloodstream. The contents not absorbed are collected into the rectum and eliminated through the anus as fecal waste.

7. As mentioned earlier in this chapter, the movement of contents through the alimentary canal is brought about by **peristalsis**, the wave like motion which is caused by the involuntary muscles of the canal.

8. The following terms are used to describe the alimentary system:

bil - bile

chol - bile

col - colon

gastr - stomach

gloss - tongue

glotl - tongue

hepat - liver

ile - intestines (ileum)

insul - insulin

nutri - nourish

or - mouth

peps - digest

pept - digest

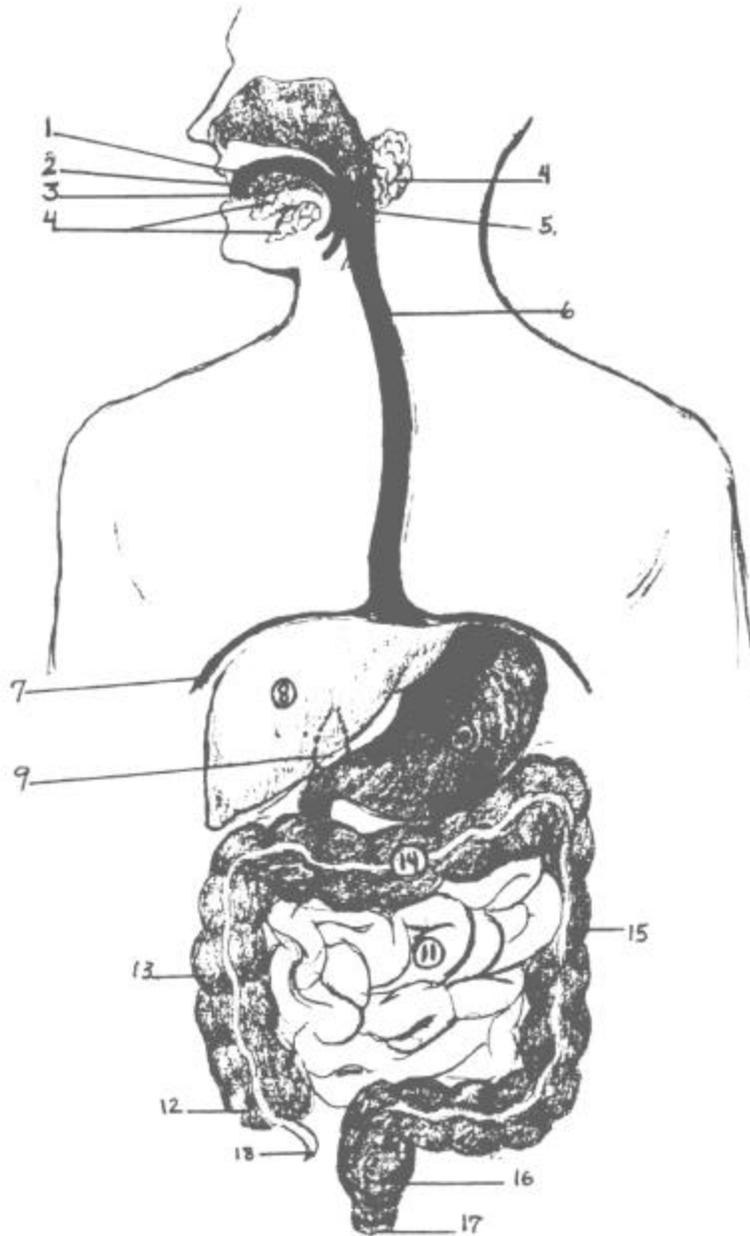
phag - eat

proct - anus

sial - saliva

stomata - mouth

9. A **colonoscopy** is the visual inspection of the colon by means of a flexible endoscope. A **proctoscope** would view the rectum and anus areas and a gastroscope would view the stomach. **Stomatitis** is an inflammation of the mouth. A cholecystectomy is the surgical removal of the gall bladder. An **ileostomy** is the surgical creation of an opening in the ileum through the abdominal wall, thus creating a **stoma** (mouth) for the removal of fecal wastes.



DIGESTIVE SYSTEM

- | | |
|--------------------|----------------------|
| 1. Mouth | 10. Stomach |
| 2. Teeth | 11. Small intestine |
| 3. Tongue | 12. Cecum |
| 4. Salivary glands | 13. Ascending colon |
| 5. Pharynx | 14. Transverse colon |
| 6. Esophagus | 15. Descending colon |
| 7. Diaphragm | 16. Rectum |
| 8. Liver | 17. Anus |
| 9. Gallbladder | 18. Appendix |

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INTEGUMENTARY SYSTEM

1. The **skin** or **integument** is not often thought of as a system, but the skin and its appendages play an important role in maintaining homeostasis. The **skin** is composed of two layers: the **epidermis** and the **dermis**. The skin's appendages are the **hairs** and **nails**. See the illustration for a diagram of skin. The primary function of skin is to provide protection from the environment. It protects deeper tissues from injury by containing the fluids within the body to keep the tissues moist and viable, and creates a barrier so that foreign organisms cannot penetrate and cause injury or disease. It also protects us from the ultraviolet rays of the sun.
2. The **epidermis** is the outer layer of skin, which is a thin layer (except on the palms of the hands and soles of the feet) of epithelial tissue. The exposed outer portion is actually made up of dead skin cells that are constantly shedding off and being replaced with new tissue from the bottom. The new cells continue to move upward toward the surface where they die and are sloughed off. The epidermis contains only a few nerve cells and no blood vessels. The epidermis has many delicate creases in its outer surface. These creases help give skin its elasticity. The palms of the hands and the soles of the feet differ from the other areas. These areas have ridges and grooves which become elaborated loops and whorls as they extend out the digits (fingers and toes). These intricate patterns are what we call **fingerprints** and **footprints**. These same ridges and grooves are what enable us to achieve a firm grasp when holding or walking on smooth objects. These elaborate loops and whorls are unique in that none are alike, which is why we can use fingerprints and footprints to identify individuals.
3. The **dermis**, which lies underneath the epidermis, is thicker than the top layer and provides cushioning during injury. This layer contains a dense network of blood vessels (capillaries) and numerous nerve cells. The capillary network not only provides needed nutrients to the skin tissue but helps regulate body temperature. When the vessels dilate, large amounts of blood are circulated to the exterior surface and heat is radiated to the outside of the body. During colder temperatures, the vessels constrict to conserve body temperature. Thus the skin serves as a temperature regulator by controlling the amount of heat loss to the outside or retained by the body. The nerve cells located in the dermis serve to help us communicate with our environment. These nerve cells help communicate stimuli to the nervous system in order to perceive **pressure, pain, heat, cold, and touch**. The dermis also contains cutaneous glands of which there are two types: **sweat** (sudoriferous) and **oily** (sebaceous). The sweat glands help with temperature regulation. As the body temperature rises, the nervous system alerts these glands and they respond by producing sweat which is excreted to the outside of the body and is evaporated. This process lowers the body temperature. The oily glands are located around hair follicles and secrete sebum which coats and protects hair follicles.

4. The **appendages** of the skin are the **hairs** and **nails**. **Hair follicles** are surrounded by nerve cells which increase our awareness to touch. They are surrounded by tiny bundles of smooth muscles which, when contracted, help put pressure on the oily glands to secrete sebum. These tiny clusters of smooth muscles are also responsible for giving rise to "**goose bumps**" when they contract as a group. The **nails** are very hard epithelial cells which are located at the end of each digit (finger/toe). Their primary function is to serve as a barrier to wear and tear to the end of the digits.

5. The skin and its appendages serve as our first line of defense against infection and invasion by organisms. Keeping the skin intact decreases our susceptibility to disease processes. Large areas of skin loss (such as in burns) can be fatal due to loss of body fluids and infection.

6. The following terms are used to describe the integumentary system:

cut - skin

derm - skin

hidr - sweat

onych - nail

pell - skin

pil - hair

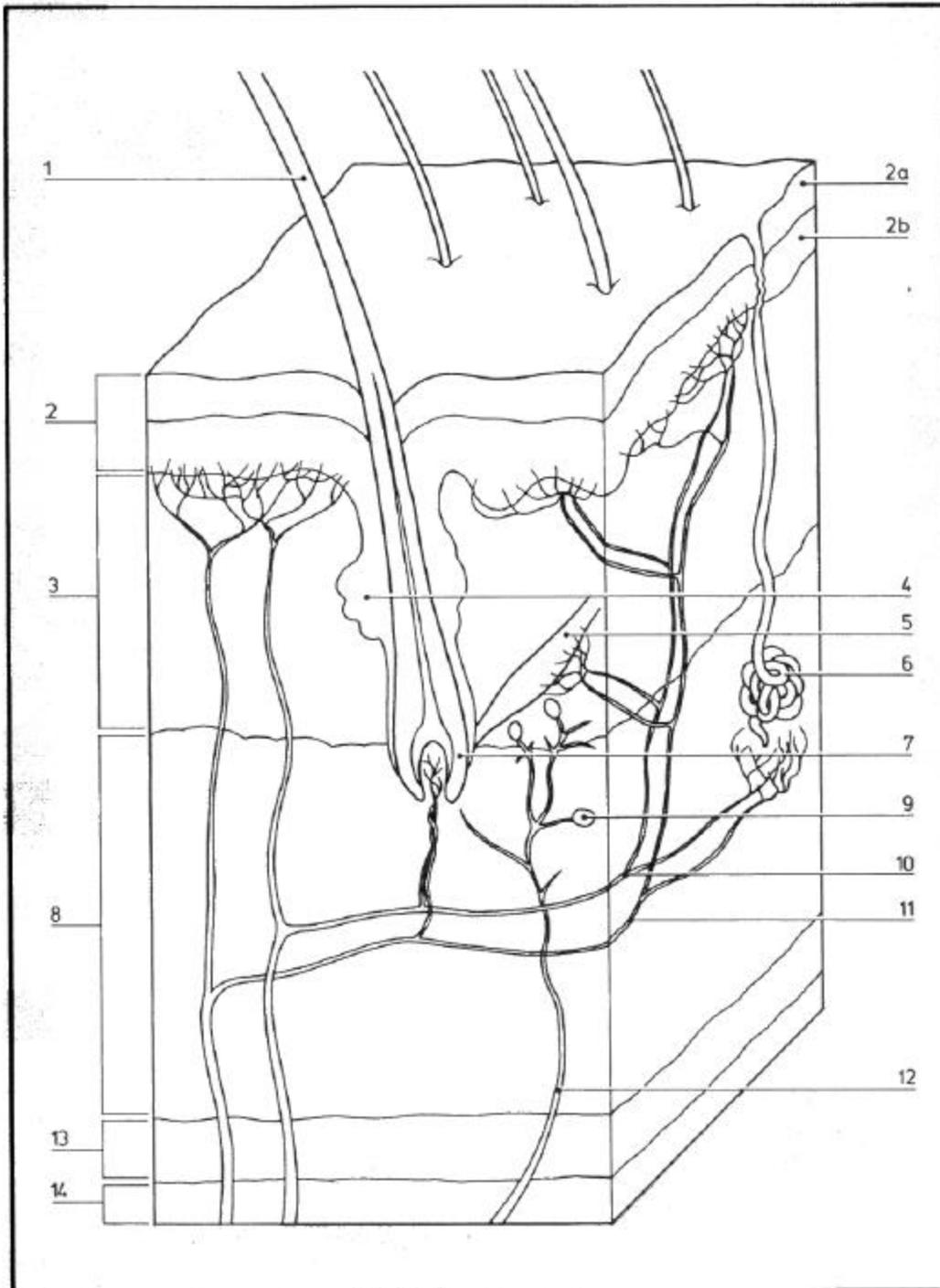
sarc - flesh

tact - touch

teg - to cover

7. A **dermatologist** is a physician who is concerned with the diagnosis and treatment of skin disorders. **Dermatitis** is an inflammation or infection of the skin. The **integumentary system** is the outside covering of the human body.

Skin



Section through hairy skin

- 1 Hair shaft
- 2 Epidermis
- 2a Layers of keratinization
- 2b Germinative layers
- 3 Corium (dermis)
- 4 Sebaceous gland
- 5 Arrector pili

- 6 muscle
- 6 Sweat gland
- 7 Hair bulb
- 8 Subcutis (subcutaneous tissue)
- 9 Bulbous nerve ending
- 10 Branch of vein
- 11 Branch of artery
- 12 Cutaneous nerve

- 13 Deep fascia
- 14 Muscle layer

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ENDOCRINE SYSTEM

1. The **endocrine system** is unique in that it is not an anatomically connected system. The glands that comprise this system are located throughout the human body. The term endocrine means to secrete from within. The glands do not have ducts and are sometimes referred to as the "**ductless glands.**" The endocrine glands deliver their secretions directly into the bloodstream where they are directed throughout the body. The glands secrete substances called **hormones**. Hormones are chemical substances which tell other tissues of the body to perform a task. Some hormones even direct other endocrine glands. They are directly responsible for growth and development, the movement of chemicals in the body, blood pressure, labor and lactation (breast milk), metabolism, stress responses, and other body functions. The major endocrine glands are the **pituitary** (hypophysis), **thyroid**, **thymus**, **parathyroids**, **adrenal glands**, **pancreatic islets**, **ovaries**, and the **testes**. See the illustrations for the female and male endocrine systems.

2. The **pituitary gland** (hypophysis), which is called the **master gland** because of its control over the functions of the other endocrine glands, regulates growth (skeletal), reproductive activities, muscle, and blood functions. The **thyroid gland** regulates metabolism and requires the compound iodine for normal function. The **parathyroid glands**, usually there are four, control the amount of calcium in the blood. The **adrenal glands** are responsible for our responses to stressful situations. During emergency situations the suprarenals secrete adrenalin which acts on smooth muscles, and increases the circulation of glucose for use by the bodies tissues. This effect is known as the "**fight or flight**" syndrome. This reaction allows the body to prepare to fight for its life or remove itself from the situation by providing the energy necessary to generate the response. The **pancreatic islands** or **islands of langerhans** of the pancreas secrete **insulin**. Insulin regulates the sugar content of the body. As mentioned in the urogenital system section, the **ovaries** and **testes** secrete hormones that control secondary female and male sex characteristics.

3. The following terms are used to describe the endocrine system:

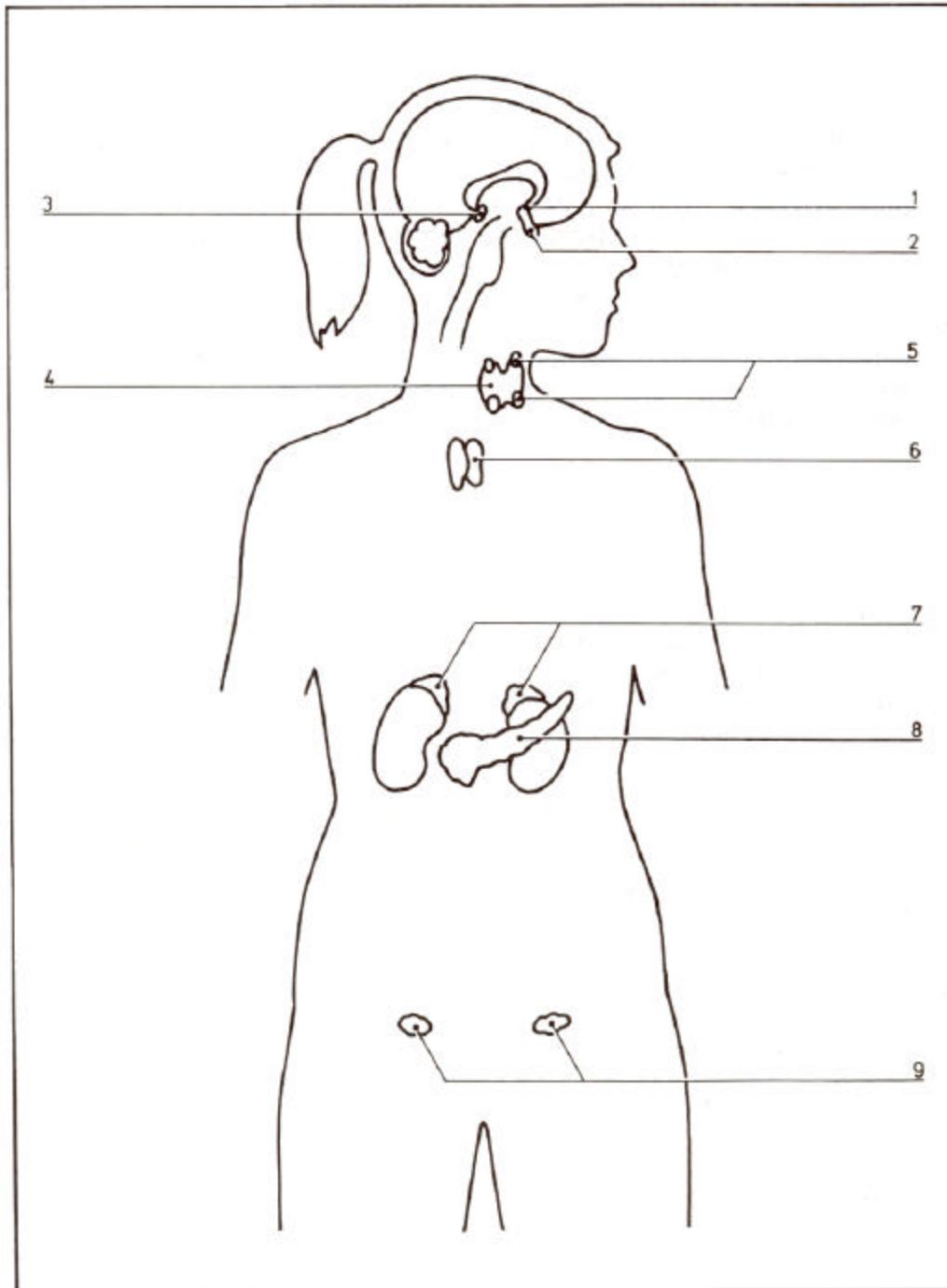
adren - adrenal gland (suprarenal)

insul - insulin

thyr - thyroid

4. An **insulin pump** is a device which is implanted under the skin which delivers synthetic insulin for the metabolism of sugar. A **thyroidectomy** is the surgical removal of the thyroid gland. **Thyropenia** is a condition where the thyroid gland does not produce enough of the thyroid hormones.

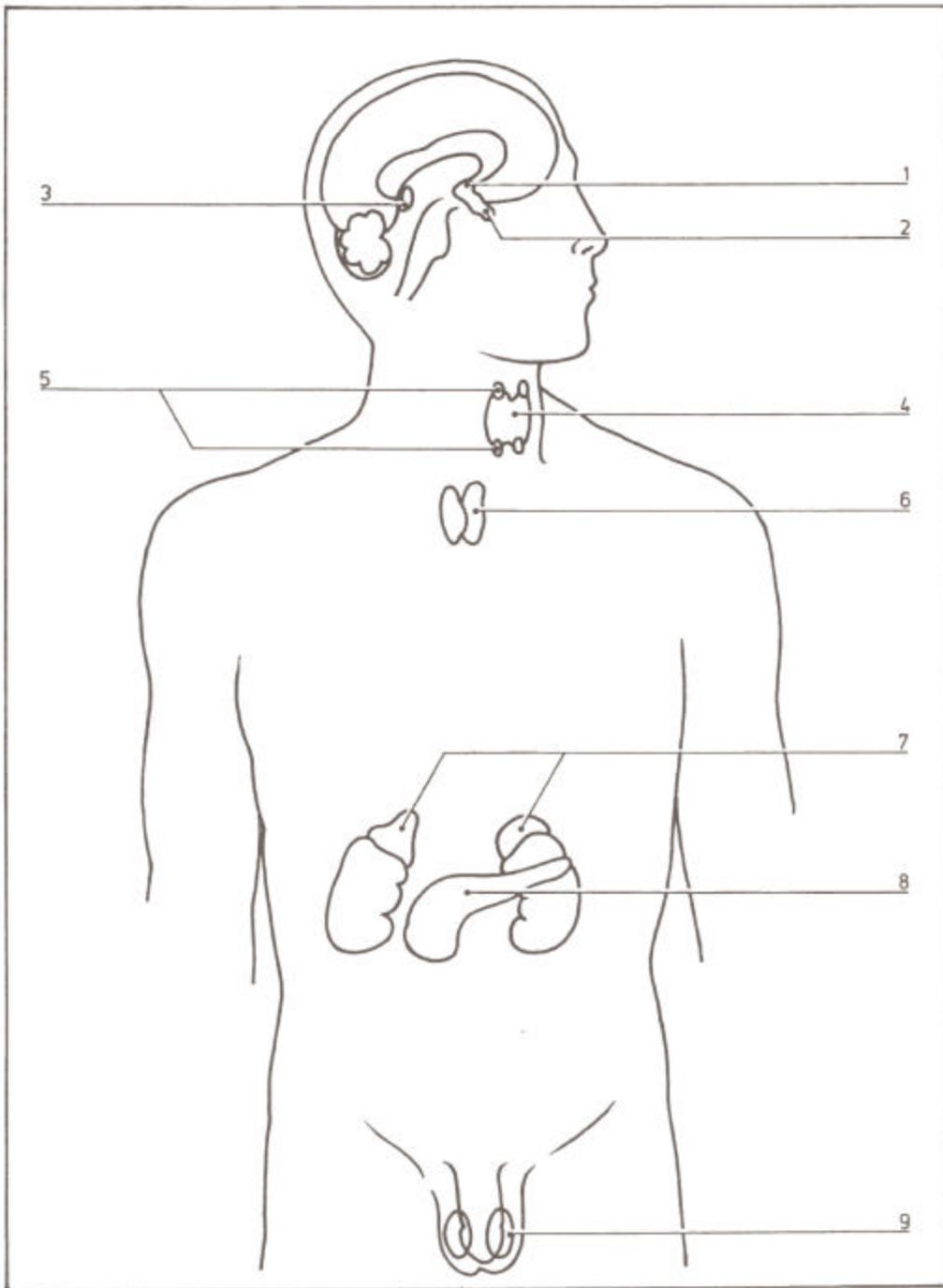
DIAGRAM: FEMALE



- 1 Hypothalamus
- 2 Pituitary gland (hypophysis)
- 3 Pineal gland (epiphysis)
- 4 Thyroid gland
- 5 Parathyroid glands
- 6 Thymus
- 7 Adrenal (suprarenal) glands
- 8 Pancreas
- 264 9 Gonads (ovaries)

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DIAGRAM: MALE



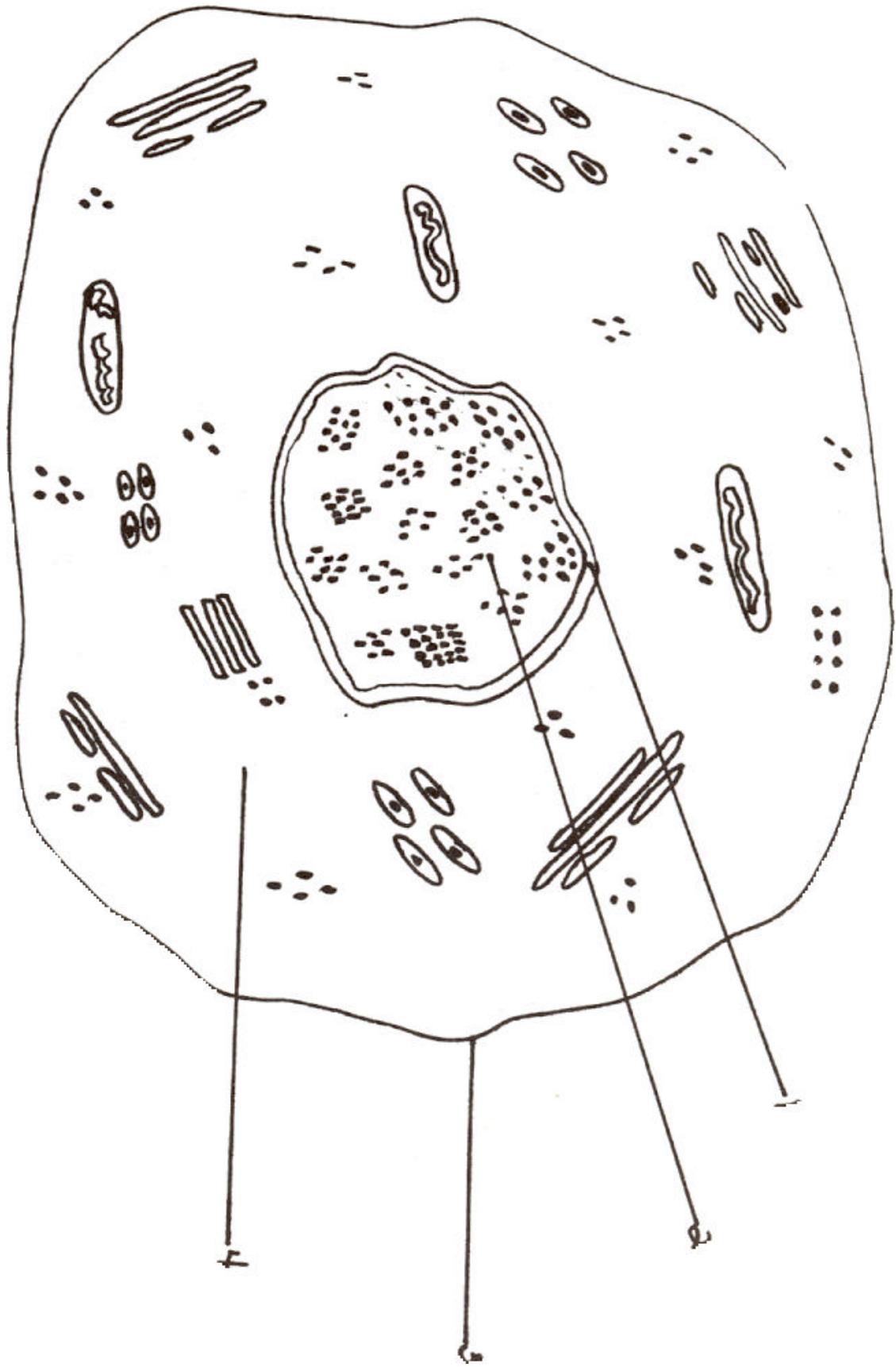
- 1 Hypothalamus
- 2 Pituitary gland (hypophysis)
- 3 Pineal gland (epiphysis)
- 4 Thyroid gland
- 5 Parathyroid glands
- 6 Thymus
- 7 Adrenal (suprarenal) glands
- 8 Pancreas
- 9 Gonads (testes)

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CYTOLOGY

1. Cytology is the study of the structure and function of cells. Cells are the basic building blocks of all living things. Cells are microscopic in size and each specializes in a particular function. Although cells differ functionally, they all have common physical features and multiply by the same basic process. Cytology is necessary for the medical supply technician in order to understand how diseases are transmitted and how to control the spread of diseases through infection control mechanisms.
2. The basic structure of a human cell contains: a **nucleus**, a **nuclear membrane**, **cytoplasm**, and a **cell membrane**. See the illustration for a diagram of a cell. The **nucleus** of the cell contains the genetic substance which carries all the information involved in determining the genetic or hereditary makeup of each individual. This genetic substance is called **DNA** (Deoxyribonucleic Acid). DNA molecules are arranged as a double helix or double spiral chains which are connected together by amino acids. These connections are arranged specifically to generate an individual's traits. During cell multiplication, DNA thins out into threads which become chromosomes. Each cell in the human body contains 46 chromosomes. A **nuclear membrane** surrounds the nucleus. **Cytoplasm** is the jelly-like filled area outside of the nuclear membrane. This area is the work area of the cell and contains numerous structures (intracellular bodies and organelles) that produce energy for the cell's functions. Cellular functions include protein synthesis and cellular metabolism (growth, maintenance, and repair). The cytoplasm is surrounded by a **cell membrane**.
3. New cells are needed on a continuous basis and the requirements change as we age. As infants, children, and adolescents, the human body requires numerous new cells for growth and development. As we age new cells are required to replace those that are dying. The skeletal system's cells are replaced every 7 years. Taste buds in the mouth are replaced every 30 hours. Blood cells are in constant demand by the body. However, there are some types of cells that are not replaced as they age and die. The muscle and nerve cells are examples of cells that are not replaced.
4. Cells multiply by a process called **mitosis**. When the process is completed, two identical cells emerge. The process begins when the 46 chromosomes thicken, contract, and form 23 pairs. They then proceed to make 23 exact copies of themselves through a process called **replication**. When replication is completed, the 23 pairs line up along the center of the cell and the new chromosomes split and go to the opposite ends. A new cell membrane forms across the middle of the cell, the cell then divides, the chromosomes begin to lengthen, and two identical cells are formed.
5. **Cancer** is usually caused by cellular genes that have been abnormally activated or mutated. These cells are usually those that control cell growth and mitosis. These abnormal cells are called oncogenes. **Oncology** is the study of tumors.



ANATOMY AND PHYSIOLOGY

TRUE/FALSE

1. The study of human anatomy and physiology provides the medical supply technician with basic knowledge in order to understand the reasons for policies and procedures.
2. A system is defined as a group of systems working together to achieve common goals.
3. The basic building block of all living things is called the neuron.
4. Bones are strong fibrins bands.
5. The skeletal systems forms the hard framework which contains the human body systems.
6. The spinal column is an example of bones held together by synovial joints.
7. A surgical instrument used to cut a joint is called a ligatome.
8. A muscular system provides for our ability to maintain posture.
9. Striated muscle has a smooth appearance under the microscope.
10. Skeletal muscles are attached to bones by ligaments.
11. Voluntary muscles tire easily.
12. The digestive process begins after food is swallowed.
13. Food is first taken into the canal through the mouth.
14. As the contents move through the large intestines water is added for easier passage.
15. An inflammation in the mouth is called stomatitis.
16. A cholecystectomy is the surgical removal of the gallbladder.
17. A colonoscopy is the visual inspection of the colon by means of a rigid telescope.
18. In the mouth food is mixed with chyme.

19. In the small intestine chyme is mixed with the secretions from the liver, biliary tract and the pancreas.
20. The alimentary systems main function is to take in nutrients and produce white blood cells.
21. The small intestine is composed of three parts, the duodenum, jejunum and the ileum.
22. The kidney can filter a quart of blood per minute.
23. The human body must have at least one functioning kidney to maintain life.
24. Human reproduction begins when the sperm penetrates the fallopian tubes.
25. The genital system is responsible for filtering waste products from the blood and eliminating from the body.
26. An orchiectomy is the surgical removal of the prostate gland.
27. A gynecologist is a physician who specializes in the reproductive system and diseases associated with women.
28. The bladder is where urine is formed.
29. The glands that comprise the endocrine system lead into the pelvis of the kidney.
31. The glands of the endocrine system secrete substances called hormones.
32. Growth and development are responsibilities of the endocrine system.
33. The pituitary gland is called the master gland, because of its control over the functions of the other endocrine glands.
34. The thyroid gland controls the amount of calcium in the blood.
35. The suprarenal glands regulate metabolism and requires the compound iodine for normal functions.
36. The aruba islands or islands of the Bahamas secrete insulin.

37. A device that delivers synthetic insulin for the metabolism of sugar is called an insulin pump.
38. The endocrine glands deliver their secretions directly into the lungs where oxygen is directed throughout the body.
39. Cytoplasm produces energy for the cells function.
40. All human cells are replaced when they die.
41. Cells are basic building blocks of all living things.
42. DNA is the genetic substance which determines the genetic or hereditary traits of each individual.

COMPLETE THE BLANKS

43. The skeleton is made up of _____ bones.
44. Bones are _____ by their shape.
45. The four classifications of bones are _____, _____, _____, and _____.
46. _____ is the study of bones.
47. Bones are held in place by _____.
48. Muscular _____ allow for movement of the bones at the joint.
49. The minerals _____ and _____ make bones hard and dense.
50. _____ is the inflammation of a bone.
51. Arthrology is the study of _____.
52. The three types of joints are _____, _____, and _____.
53. Bones of the skull are examples of _____ joints.
54. _____ joints allow for free movement.
55. Examples of synovial joints are the _____, _____, and _____.

56. _____ fluid helps lubricate and protect a free movement joint.
57. _____ is the study of the structure of the human body.
58. _____ is the study of the functions of the human body.
59. The human body is made up of _____ systems.
60. The human body is made up of the _____, _____, _____, _____, _____, _____, _____, and _____ systems.
61. There are three types of muscles, _____ (or skeletal), _____ (or visceral), and _____ (or heart).
62. Voluntary muscles are also called _____ muscles.
63. _____ muscles provide for the movement of blood throughout the vascular system.
64. Involuntary muscles are sometimes referred to as _____ muscles.
65. _____ is the study of muscles.
66. The vascular system is made of two parts, the _____ and the _____ system.
67. The vascular system consists of the _____, _____, _____, _____, _____, _____, and _____.
68. The _____ system is responsible for transporting _____ which is used by the respiratory system.
69. The lymphatic system consists of _____, _____, and _____.
70. The lymphatic system helps remove foreign _____.
71. The heart is a four chambered _____, which facilitates the circulation of _____.
72. The four chambers of the heart are the _____, the _____, the _____, and the _____.

73. The _____ veins are the only veins in the body that carry oxygenated blood.
74. The _____ is the largest artery of the human body.
75. Arteries carry _____ to the tissues of the body.
76. Arteries branch of into _____, which further branch of into _____.
77. It is at the _____ where nutrients, oxygen and other products are absorbed for use by the bodies tissues.
78. Veins carry _____ blood back from the tissue to the heart.
79. Waste products are removed from the tissue by _____, which are branches of the _____.
80. In 4 hours, _____ quarts of blood pass through the heart.
81. The average adult has approximately five quarts of blood in their body, which is recycled through the heart once every _____.
82. Blood consists of _____, _____, _____, and _____.
83. When blood is pumped through the lungs _____ attaches itself to the _____.
84. During physical exercise the muscular system requires large amounts of _____.
85. _____ causes muscles in the _____ to contract and extend which helps squeeze and push blood along the veins.
86. The _____ system drains excess fluids, transports dead blood cells, and _____ products away from the tissue.
87. _____ are cells that eat up disease producing cells.
88. The lymph nodes are located throughout the body along the _____.
89. The spleen, tonsils, lymphnodes and part of the digestive tract act as _____ in that they filter and fight _____.

90. The primary lymphoid organs are the _____ and _____.
91. The urinary systems consists of the _____, _____, _____, and _____.
92. _____ are tiny filtering units of the kidney.
93. The human body excretes about _____ of urine daily.
94. The _____ produce the female hormones estrogen and progesterone.
95. The _____ stores the urine until it is eliminated outside of the body by the _____.
96. A hysterectomy is the surgical removal of the _____.
97. The artificial removal of waste products from the blood is called _____.
98. The _____ produce sperm and testosterone.
99. The urinary (or renal) system is responsible in the formation and elimination of _____.
100. The body maintains _____ by controlling the acid-base balance of the blood and maintaining adequate levels of water, salts, proteins and electrolytes.
101. _____ is the study of structure and function of cells.
102. The basic structure of the human cell consists of _____, _____, _____, and _____.
103. Each cell in the human body contains _____ chromosomes.
104. _____ is the reproductive cell division process.
105. Skeletal system cells are replaced every _____ years.
106. Two examples of cells that do not replace themselves are _____ and _____ cells.
107. The jelly-like filled area outside the nuclear membrane called the work area is the _____.
108. The _____ of the cell contains the genetic substance which determines the genetic makeup of each individual.

MULTIPLE SELECTION

109. The skeletal system provides _____ to the vital internal organs.

- a. water
- b. nerve stimulation
- c. protection
- d. heat

110. Bone marrow is:

- a. soft, fatty tissue which is yellow or red
- b. found inside most bones
- c. firm red and white blood cells
- d. all of the above

111. Peristalsis is: _____.

- a. movement of food from mouth to stomach
- b. rhythmic action of the cardiac muscle
- c. contracting and extension of tendons.
- d. wavelike motion of large and small intestine

112. The alimentary system is responsible for:

- a. Circulation of blood
- b. Carries messages to all parts of the body
- c. Gives form and support to the body
- d. The digestion of food

113. The alimentary canal is about how long:

- a. 3 Ft.
- b. 13 Ft.
- c. 300 Ft.
- d. 30 Ft.

114 Which of these organs are part of the alimentary canal?

- a. Mouth, esophagus and lungs
- b. Stomach, small intestine and rectum
- c. Right atrium, anus, liver
- d. Large intestines, biliary tract and vena cava

115. When chyme leaves the stomach it enters the;
- Liver
 - Small intestine
 - Large intestine
 - Kidneys
116. The small intestine is divided into these three parts:
- Nasal cavity, duodenum, spinal cord
 - Jejunum, pulmonary artery, descending colon
 - jejunum, duodenum, ileum
 - Sigmoid colon, ileum, duodenum
117. The large intestine is divided into these five parts:
- Ascending colon, transverse colon, descending colon, sigmoid colon, rectum and anus
 - Rectum, ascending colon, descending colon, vertical colon, rectum and anus
 - Transverse colon, sigmoid colon, rectum and anus, Horizontal colon, and descending colon
 - Sigmoid colon, ascending colon, descending colon, transverse colon, jejunum
118. The movement of contents through the alimentary canal is brought about by:
- The voluntary muscle movement of the legs
 - The wavelike motion of the trachea
 - Constant pressure on the stomach, caused by voluntary muscle movement
 - Peristalsis the wavelike motion which is caused by the involuntary muscles of the canal
119. Food is first taken into the alimentary system through the:
- Nasal passages
 - Subclavian artery
 - Ascending colon
 - Mouth
120. The accessory glands secrete enzymes which aid in the breakdown of large compounds into smaller ones so they can be readily absorbed into the:
- Chyme
 - Sigmoid colon
 - Blood stream
 - Respiratory system

121. What instrument is used to view the rectum and anus areas:

- a. Endoscope
- b. Gastroscope
- c. Telescope
- d. Proctoscope

Matching:

122. Myo

a. Involuntary

123. Tendonitis

b. Muscle

124. Striated Muscle

c. Inflammation of a tendon

125. Smooth Muscle

d. Voluntary

126. Cytology

e. Basic building blocks

127. Cells

f. Cellular multiplication

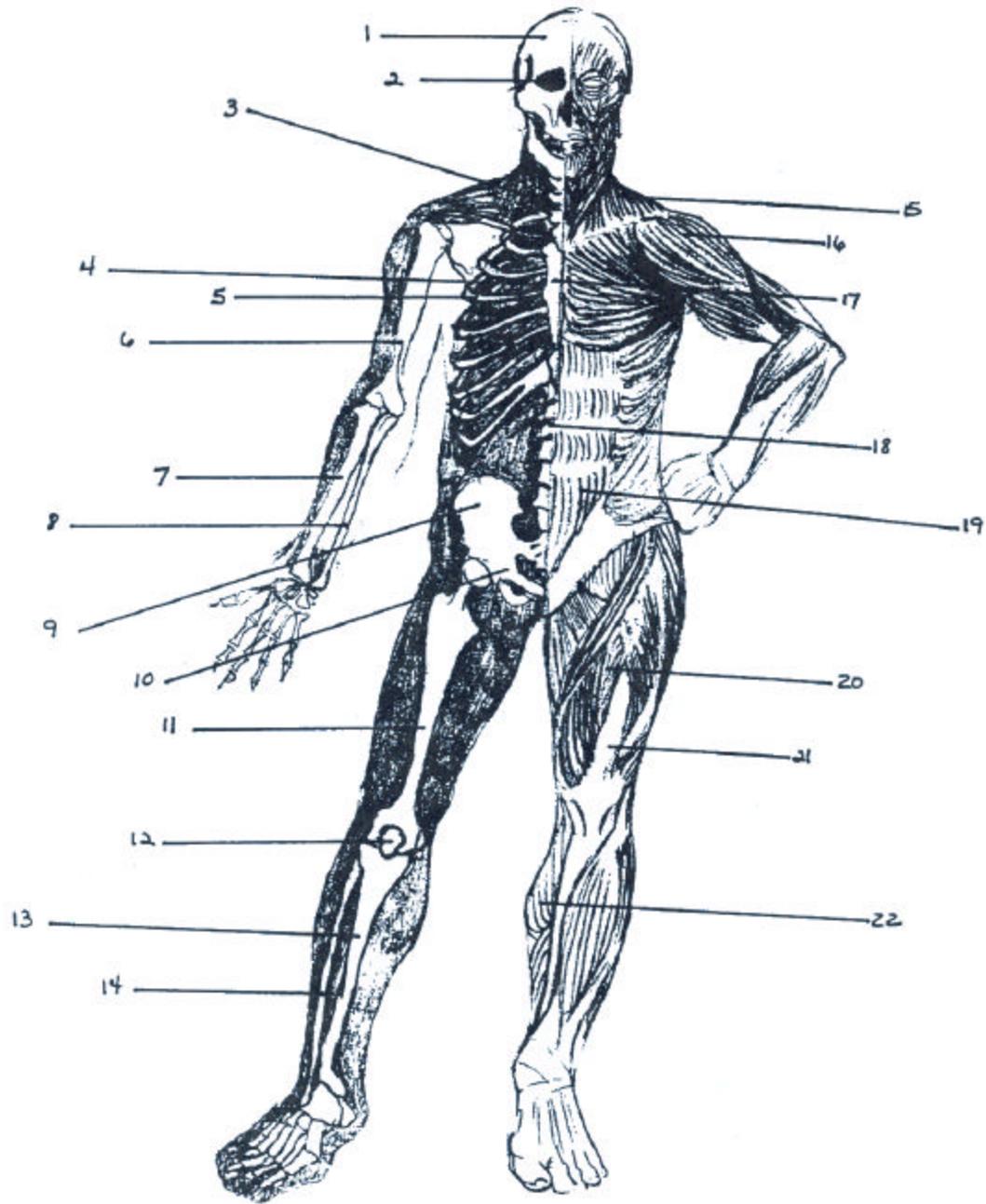
128. Mitosis

g. Study of structure and function of cells

129. Meiosis

h. Reproductive cell division process

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| 5. | 12. | 19. | |
| 6. | 13. | 20. | |
| 7. | 14. | 21. | |

INTRODUCTION SPD

MICROBIOLOGY

DECONTAMINATION

PACKAGING

STERILIZATION

SURGICAL INSTRUMENTATION

STERILE STORAGE

DISTRIBUTION

INVENTORY MANAGEMENT

ANATOMY AND PHYSIOLOGY