Department of Veterans Affairs

Supply, Processing and Distribution

Training Manual

Level One Training

Supply, Processing, and Distribution

Training Manual – Level One Training

Index

Section One: Introduction to SPD

Estimated Contact Time: **45-65 minutes**

This module covers:

- the history and purpose of the SPD organization,
- organizational structure,
- the role SPD plays in infection control,
- and the basic concepts required to understand SPD functions.

Following instruction, you should be able to perform the following:

- ☑ Identify the role of SPD.
- ☑ Identify SPD practices and process flows.
- ☑ Identify functional areas.
- ☑ Specify the need for patient confidentiality and cost containment.
- ☑ Distinguish among people, material, work, and air flow.
- ☑ Identify SPD workplace hazards and associated tools and procedures.
- ☑ Identify regulatory agencies which affect health care facilities.
- ☑ Identify requirements associated with working in the SPD environment.

The Role of SPD

Although operations vary from medical center to medical center, SPD's goal is the same: to support medical health care professionals by providing a continuous flow of *sterile* and *non-sterile* equipment and supplies to all users.

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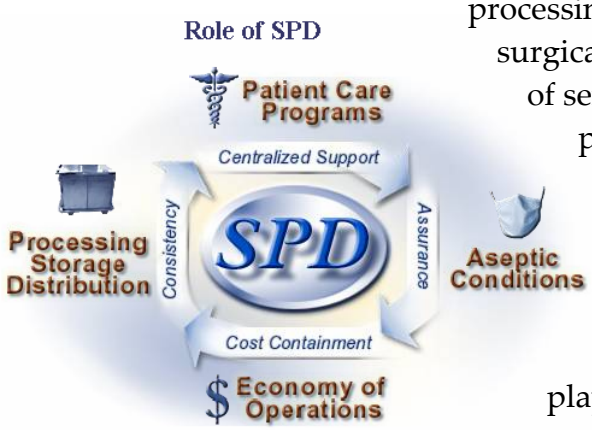
SPD's mission is to ensure controlled aseptic conditions in the processing, storage, and distribution of medical and surgical supplies, while maintaining a high degree of sensitivity to cost containment. Without SPD personnel on the job, other medical center professionals would lose valuable direct patient treatment time sterilizing surgical instruments, retrieving patient care equipment, and ordering and stocking medical and surgical supplies. SPD also plays a critical role in infection control. The support that SPD provides is essential to every organization in a medical center that provides patient care.



Dual Role

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.

A Brief History

Today's modern hospitals are very different from how medicine was practiced in the past. Prior to the 19th century little or nothing was known about what caused the spread of infectious diseases.

1800s In the late 1800s and early 1900s doctors traveled around from patient to patient, often spreading disease as they went. Even in hospitals, *antiseptic* techniques were not practiced. In 1854, an Englishman named John Snow published "On the Mode of Transmission of the Cholera"—the first scientific study on the transmission of an infectious disease. Snow correctly traced the spread of the disease to a water supply contaminated by washing soiled linens from the sick. From 1870 to 1886, Louis Pasteur did his groundbreaking work on microorganisms and the spread of infectious diseases. Many of the basics of sterilization derive from Pasteur's work.

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1900s Sterilization and antiseptic techniques became more common in the 1900's, but individual users still processed medical and surgical supplies. There was no coordinated central system for processing and managing surgical and medical supplies. During the 1940's, W.B. Underwood and John J. Perkins promoted the concept of centralizing supply, processing, and distribution functions. In 1956, John J. Perkins published the book: "Principles and Methods of Sterilization", which is currently in its 7th edition. Due to Underwood and Perkins work, SPD is a critical line of defense in preventing the spread of *nosocomial*—or hospital-acquired—diseases or infections.

1967 Before 1967, SPD was known as Processing and Distribution (PAD). PAD organizationally was under Nursing Services. Its function was primarily the distribution of supplies. Sterilization and instrument preparation were performed by individual user organizations such as the Operating Room and Dental. 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 decontamination, sterile processing, and inventory management.

2000 SPD today is traditionally divided into three functional areas: Decontamination, Preparation, and Inventory Management & Distribution.

Functional Areas

Decontamination

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

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endoscope washers, washer/sterilizers, washer/sanitizers, cart washers, and steam guns.

Preparation

The main sterilization methods are steam and gas. Preparation is where items to be sterilized are inspected, assembled, and packaged for sterilization.

Instruments are carefully examined to make sure they are working properly, they are not bent or broken, and that all parts are present. Items are then assembled and packaged for sterilization using a set of assembly guides or count sheets. Aseptic technique is followed at all times.

Distribution & Inventory Management

The Distribution Area is responsible for the requisition, issue, and maintenance of medical/surgical supplies. Stock is divided into primary—items which are stored within the confines of SPD Clean/Sterile Storage—and secondary which are stored in user areas such as wards, nursing home care units, and ICUs. In addition, Distribution is also responsible for *case cart* assembly, *exchange cart* inventory, *secondary inventory*, and *telephone* and/or call window distribution.

Distribution may be subdivided into:

- A receiving and breakout room where supplies are accepted from the warehouse, depot, or supplier.
- Bulk storage—a separate area where items are stored until they are unpacked and moved to the clean/sterile storage area. In bulk storage, items are stored in their cardboard containers.
- Clean sterile storage where SPD's *primary stock* is kept for easy access.

In addition to storing supplies, SPD is responsible for ordering and maintaining adequate inventory and dispensing supplies to users as they are needed.

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Protective Clothing

Each area within SPD has a dress code which must be strictly adhered to. Only properly attired, authorized personnel are allowed in SPD. The purpose of dress codes is to prevent cross-contamination, to maintain a professional appearance, and to protect the employee.

To minimize the spread of *microorganisms* and bacteria, employees remove protective clothing and wash their hands before leaving the decontamination unit. They then put on freshly laundered scrubs.

Staff in the preparation unit must wear special clothing to keep the medical items free of lint, hair, and other foreign matter.

- 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.

Distribution has its own dress code which is aimed at presenting a professional image and helping others identify SPD staff. The traditional blue smock and white pants are worn, unless the nature of the assignment dictates otherwise.

Patient confidentiality

Medical supply technicians must be aware of their responsibility for patient confidentiality. The disclosure of a patient's medical or personal condition must never be communicated to others who are not directly involved. Regardless of how information was obtained, it must be kept confidential. Employees should not discuss patient issues while at lunch, on breaks, or in public access areas.

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Cost containment

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 clear communication with users to set adequate stock levels and eliminate unofficial inventories. Medical supplies and equipment are very expensive. Theft and fraud have a negative impact on medical centers, are punishable by law, and must be reported immediately.

Infection Control

SPD is critical in the defense against harmful microorganisms. Every precaution must be taken to minimize disease transmittal and prevent cross contamination.

Infectious control precautions include:

- **Paying careful attention to personal hygiene and good health to minimize the potential for acquiring or transmitting disease**
- **The use of protective equipment and frequent hand washing to eliminate cross contamination**
- **Ensuring that medical supplies are decontaminated and processed under the best possible conditions**
- **Practicing Universal Precaution/Standards which mandate that all contaminated items be treated as if they are infectious**
- **Adhering to established dress codes to prevent cross contamination**
- **Participating in the hospital's Infection Control Committee**
- **Practicing strict environmental control**

Environmental Control

Air flow from clean to dirty. By creating a positive air flow in clean areas and a negative air flow in dirty areas, the movement of airborne microorganisms can be minimized.

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Work flow, the order in which medical items are received, processed, and dispensed, moves from dirty to clean. Contaminated, reusable items are transported to the decontamination area by means that protect people and the environment.

People flow moves from clean to dirty. It is tightly restricted to prevent the spread of microorganisms commonly found on the human body and clothing. You must change clothing and shower before returning to a clean area.

Material flow refers to the movement of clean/sterile supplies and reusable and contaminated items. Contaminated items enter the decontamination section in covered containers and are cleaned and disinfected then moved to the preparation area where they are sterilized. Products must be removed from shipping cartons before being stored on clean, sterile shelves.

Workplace Hazards

There are a variety of safety hazards associated with each SPD area. With proper training and attention, incidents can be kept to a minimum. Areas where hazardous materials are used must have warning signs posted. Information, in the form of Material Safety Data Sheets, is maintained on the characteristics of hazardous substances used in the workplace, and there are standard procedures in place to deal with the threat of fire or similar dangers.

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Workplace hazards can be categorized into six different areas:

Environmental	Includes cuts or sticks from needles, falls from wet floors in the decontamination area, and burns from steam sterilizers in the preparation area.
Chemical	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.
Biological	Generally associated with the pickup and decontamination tasks, biological hazards arrive on equipment and supplies which have been contaminated with potentially pathogenic microorganisms.
Electrical	Includes shocks from frayed or cut cords, damaged equipment, and improper cleaning of equipment.
Mechanical	Usually involves equipment operation. SPD uses large automated pieces of equipment, such as automatic autoclave doors, automatic transport systems, cart washers, dumbwaiters, and elevators.
Physical	Result from improper lifting, pulling, pushing, and bending.

Hazard communications are an ongoing 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,

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and ingredients. The MSDS also gives instructions in the event of hazardous contact with the product or a leak or spill. For any hazardous material to which SPD technicians may be exposed, an MSDS must be on file and training will be conducted annually. A copy of the MSDS file must be accessible to all employees for easy reference.

Fire Safety Requirements (RACE)

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.

Rescue/Remove—all persons in immediate danger

Alarm/Alert—activate fire alarm; dial appropriate number and inform operator where fire is located

Confine/Contain by closing doors/windows

Extinguish/Evacuate—extinguish the fire if you can, if not, evacuate

Working in the SPD Environment

In the last 20 years, the SPD environment has become more complex. The skills and knowledge required have increased. There are multiple governing and policy-setting agencies at the federal, state, and local level that have an impact on health care facilities. Some of the more prominent ones include:

Occupational Safety and Health Administration (OSHA) —The federal regulatory agency responsible for safety in the workplace. Responsibilities include establishing and enforcing laws governing occupational exposure to toxic chemicals, such as EtO and glutaraldehyde.

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Environmental Protection Agency (EPA)—The federal regulatory agency responsible for protecting land, water, and air. Their responsibilities include the regulation of the manufacturing, labeling, and emissions of ethylene oxide (EtO).

Food and Drug Administration (FDA)—The federal regulatory agency responsible for the manufacture and safety of medical devices, food, and drugs. Responsibilities include the regulation of manufacture and classification of medical devices, such as infusion pumps, feeding pumps, and implantable devices.

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

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

The Joint Commission on Accreditation of Healthcare Organizations (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.

Professional organizations offer recommendations and/or guidelines which impact SPD. They provide enhancement of patient care by elevating the standards of SPD personnel. They include:

- American Society for Healthcare Central Service Personnel
- International Association of Hospital Central Service Personnel
- International Association of Hospital Central Service Material Managers
- Association of Operating Room Nurses
- Association of Practitioners of Infection Control

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- Association of the Advancement of Medical Instrumentation

SPD employees are encouraged to join professional organizations and associations to advance their knowledge of field practices. These organizations enhance patient care by elevating the knowledge and skill of SPD personnel.

Communication

Medical supply technicians communicate on a daily basis with individuals from various backgrounds. These include doctors, nurses, hospital personnel, patients, and their families. Good communication ensures that pertinent information is exchanged regarding patient care needs, meeting the user's needs and keeping medical supply technicians up-to-date on current inventory and their specific uses. Communication is essential within the SPD section. Good interpersonal relationships promote a productive work environment.

In face-to-face meetings or phone conversations, technicians must be polite and courteous. A helpful attitude promotes good will and smoother work production.

Gossip, malicious talk, and rumors lead to dissension and dissatisfaction, which can ultimately degrade the quality of service provided.

All tasks should be performed according to established procedures. Taking shortcuts or skipping procedural steps may appear to save time and be more efficient, but the result may be that supplies are not prepared correctly and may not be usable. Not following established procedures may endanger the safety of both patients and staff. The SPD Procedures Manual was developed to document and communicate standard SPD Procedures to all involved.

Terminology

Knowledge of basic medical/surgical terminology is essential for the SPD technician. Many times when items are requested, generic or "slang" terminology is used. SPD technicians must be familiar

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with the many different terms used and be willing, when necessary, to ask questions for clarification. In instances where an unfamiliar item is requested, as much information as possible should be obtained. For example, when a catheter is requested, the user 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 in understanding the relationship between root words, prefixes, and suffixes. The root is the base of the word. Think of it as the topic or subject being discussed. Prefixes, at the beginning of a word, and suffixes, added to the end of a word, modify the root.

In this module you have seen a brief overview of SPD, its history, structure, responsibilities, and requirements.

The following questions will help you review and confirm your understanding of what you have learned.

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✓ Check What You Know

1. SPD's main purpose or role is _____

   _____.

2. SPD's mission is to ensure controlled aseptic conditions in the processing, storage, and distribution of medical and surgical supplies, while

   _____.

3. SPD is the area where medical/surgical supplies and equipment are

   _____, _____, _____, and

   _____ for patient use.

4. The three main functional areas of SPD are:

   _____

   _____

   _____

5. As an SPD technician, what is your responsibility for patient confidentiality?

   _____

6. As an SPD technician, what is your responsibility for cost containment?

   _____

7. Describe the meaning of each of the following terms in the SPD environment and identify the direction of flow (clean to dirty or dirty to clean).

   - Work flow
   - People flow
   - Material Flow
   - Air flow

8. List four of the six types of workplace hazards that may be found in SPD and give an example of each.

   _____

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_____

_____

_____

9. What is an MSDS? _____

_____

10. Treating all contaminated material as if it were infectious is mandated by

_____.

11. List three regulatory agencies which affect health care facilities.

_____

_____

_____

12. List three Professional organizations that help to build SPD employees' skill and knowledge:

_____

_____

_____

13. What traits or abilities are necessary to function as a successful member of the SPD team?

_____

_____

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Terminology

The following terms were used in this module.

antiseptic	opposing sepsis, preventing or arresting the growth of microorganisms
case cart	a mobile unit equipped with supplies and equipment that are specific to a certain surgical procedure
clinical	involving or depending on direct observation of a living patient
cross-contamination	the transmission of microorganisms from one surface to another
distribution	delivering supplies from a central location to the areas where they will be used
exchange cart	a mobile supply container that is stocked with a predefined set of supplies, when some have been used the entire cart is removed for restocking and replaced with another fully stocked one
microorganisms	a living being too small to see with the naked eye
MSDS	Material Safety Data Sheet
non-sterile	not free from living organisms, especially microorganisms

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nosocomial	hospital-acquired
par level restocking	re-ordering and replacement of supplies based on a pre-determined requirement list
primary stock	supplies that are kept on hand, at-the-ready, in the SPD area
secondary inventory	medical and surgical supplies in the user areas such as wards, nursing home care units, and ICUs
sterile	free from living organisms, especially microorganisms
Universal Precaution/Standards	The practice of Universal Precaution/Standards Precautions is to be followed by all healthcare workers whose functions could bring them into contact with blood, body fluids, or body substances. All of the precautions mandate that all contaminated items are treated as if they are known to be infectious. Precautions also include frequent hand washing and the use of PPE.

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Module 1 - INTRODUCTION TO SPD

1. SPD IS A CRITICAL LINE OF DEFENSE IN PREVENTING THE SPREAD OF WHAT TYPE OF INFECTION INSIDE THE HOSPITAL?

A. RESPITORY
B. VIRAL
C. NOSOCOMIAL
D. NONE OF THE ABOVE

2. SPD IS NORMALLY SPLIT INTO WHICH OF THE FOLLOWING?

A. DECON, PREP, FINANCE
B. DECON, PREP, DISTRIBUTION
C. DISTRIBUTION, FINANCE, PREP
D. DECON, PREP, LAB

3. THE TWO MAIN METHODS OF STERILIZATION USED IN THE VA ARE?

A. STEAM, STERIS
B. GRAVITY, DRY
C. STEAM, GAS
D. GAS, STERIS

4. THE DISTRIBUTION SECTION OF SPD IS RESPONSIBLE FOR WHICH OF THE FOLLOWING IN RELATION TO MED/SURG. SUPPLIES?

A. REQUITION
B. ISSUE
C. MAINTENANCE
D. ALL OF THE ABOVE

5. THE MANDATED DRESS CODES INSIDE OF SPD SPACES ARE TO HELP?

A. PREVENT CROSS CONTAMINATION
B. MAINTAIN A PROFESSIONAL APPEARANCE
C. PROTECT THE EMPLOYEE
D. ALL OF THE ABOVE

6. TRUE OR FALSE SPD EMPLOYEES CAN DISCUSS A PATIENTS CONDITION OR MEDICAL PROBLEMS IN PUBLIC ACCESS AREA'S.

TRUE - FALSE

7. WASTE OF SUPPLIES INSIDE OF SPD CAN BE MINIMIZED BY WHICH OF THE FOLLOWING?

A. ACCURATE RECORD KEEPING
B. A & C
C. PROPER HANDLING OF SUPPLIES
D. DAILY INVENTORIES

8. TO HELP MINIMIZE THE MOVEMENT OF MICROORGANISMS INSIDE OF SPD THE AIRFLOW IN CLEAN AREAS IS_____AND IS_____ IN DIRTY AREAS?

A. POSITIVE, POSITIVE
B. NEGATIVE, NEGATIVE
C. NEGATIVE, POSITIVE
D. POSITIVE, NEGATIVE

9. WORK FLOW INSIDE OF SPD IS FROM_____TO_____?

A. DIRTY TO DIRTY
B. DECON TO PREP
C. PREP TO DECON
D. CLEAN TO DIRTY

10. PEOPLE FLOW INSIDE SPD MUST MOVE FROM _____ TO _____?

A. DIRTY TO DIRTY
B. DECON TO PREP
C. CLEAN TO DIRTY
D. NONE OF THE ABOVE

11. WHAT ARE THE SIX HAZARDOUS AREAS WITHIN SPD?

A. ENVIRONMENTAL, CHEMICAL, BIOLOGICAL, ELECTRICAL, MECHANICAL, PHYSICAL
B. ENVIRONMENTAL, CHEMICAL, BIOLOGICAL, NUCLEAR, MECHANICAL, PHYSICAL
C. ENVIRONMENTAL, CHEMICAL, BIOLOGICAL, ELECTRICAL, ANIMAL, PHYSICAL
D. NONE OF THE ABOVE

12. TRUE OR FALSE ALL POTENTIALLY DANGEROUS PRODUCTS USED IN SPD MUST HAVE A MSDS ON FILE.

TRUE - FALSE

13. RACE IS THE ACRONYM USED TO DEFINE ACTIONS IN THE EVENT OF FIRE, WHAT DOES THE "C" STAND FOR?

A. CALL OUT
B. CAMP FIRE
C. CONFINE AND CONTAIN
D. CALL 911

14. THE FEDERAL AGENCY RESPONSIBLE FOR SAFETY IN THE WORK PLACE IS KNOWN AS WHICH OF THE FOLLOWING?

A. NOISHA
B. OSHA
C. EPA
D. CDC

15. THE FEDERAL AGENCENCY RESPONSIBLE FOR THE REGULATION OF EtO USAGE IS KNOWN AS WHICH OF THE FOLLOWING?

A. NOISHA
B. OSHA
C. EPA
D. CDC

16. WHEN A USER CALLS SPD, THE SPD TECHNICIAN SHOULD ANSWER THEIR QUESTIONS WITH A_____,_____,_____ VOICE, THUS PROMOTING A SMOOTH AND PRODUCTIVE WORK ENVIRONMENT?

A. HARSH, ABRASIVE, SHOUTING
B. SLEEPY, QUITE, STRANGE
C. CLEAR, POLITE, PROFESSIONAL
D. NONE OF THE ABOVE

17. THE KEY TO UNDERSTANDING MEDICAL TERMINOLOGY IS UNDERSTANDING THE RELATIONSHIP BETWEEN ROOT WORD, PREFIXES AND SUFFIXES, BY ADDING THE PREFIX _____ THE ROOT WORD AND THE SUFFIXES AT THE _____ OF THE WORD MODIFIES THE ROOT WORD.

A. BEFORE, END
B. END, BEFORE
C. NEITHER A OR B
D. NONE OF THE ABOVE

18. "OPPOSING SEPSES, PREVENTING OR ARRESTING THE GROWTH OF MICROORGANISMS" IS THE DEFINITION FOR WHICH OF THE FOLLOWING TERMS?

A. STERILE
B. ANTISEPTIC
C. CLEAN
D. ANTIBACTERIAL

19. 'DELIVERING SUPPLIES FROM A CENTRAL LOCATION TO THE AREAS WHERE THEY WILL BE USED" IS THE DEFINITION OF WHICH OF THE FOLLOWING?

A. JOB
B. PREP
C. DECON
D. DISTRIBUTION

20. "FREE FROM ALL LIVING ORGANISMS ESPECIALLY MICROORGANISMS" IS THE DEFINITION OF WHICH OF THE FOLLOWING?

A. STERILE
B ANTISEPTIC
C. CLEAN
D. ANTIBACTERIAL

21. A LIVING BEING TOO SMALL TO SEE WITH THE NAKED EYE IS SAID TO BE A?

A. FUNGUS
B. VIRUS
C. MICROORGANISM
D. VERY SMALL PERSON

Section Two: Microbiology

Estimated Contact Time: **40-45 minutes**

This module covers:

- The basics of microbiology and why it is important in the SPD environment
- the threat of disease, infection, and cross contamination in the medical center environment
- preventative infection control measures

Following instruction, you should be able to perform the following:

- ☑ Identify and define terms associated with microbiology.
- ☑ Recognize the threat of infection and cross contamination in the medical center environment.
  - Identify the significance of spores.
  - Diagram the chain of infection.
  - Identify the four conditions required for disease transmission.
  - Define direct and indirect contact.
  - Define nosocomial infection.
- ☑ Identify preventative measures
  - Detail hand washing requirements.
  - Define Universal Precautions.
  - Identify disinfection and sterilization principles.

Why is Microbiology Important?

It is imperative that SPD technicians understand what ***microorganisms*** are and how they spread 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 must control the number of

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microorganisms present on medical supplies, instruments, and equipment.

A Brief History

Microorganisms have been around since the beginning of time, but it wasn't until the late 1600's that we began to recognize them and their role in disease and infection.

Late 1600s

Two men, Anton van Leeuwenhoek, who constructed powerful lenses, and Robert Hooke, who built compound microscopes, gave scientists the tools they needed to study microorganisms. Once the existence of microorganisms was known, the work of a number of people helped to change the way the world thought about treating people who were sick or injured.

Early 1800s

Christian Gram developed a means of staining slides of bacteria in order to help identify them. This procedure became known as the Gram Stain and is still in use today. Organisms that stain blue are said to be Gram Positive, those that stain red are Gram Negative.

Early 1900s

Louis Pasteur discovered that many diseases are caused by germs. This was one of the most significant steps in the development of modern medicine. Pasteur's work was the beginning of the science of Microbiology.

Dr. Joseph Lister expanded Pasteur's work into the field of surgery and virtually eliminated wound infections by soaking bandages in carbolic acid. This was the start of modern aseptic surgical techniques and he became known as The Father of Antiseptic Surgery.

Robert Koch studied disease transmission. He developed microscopic techniques and methods for culturing and staining

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bacteria, which improved research methods. He also pioneered the use of inoculation to prevent disease.

The Science of Microbiology

Microbiology is the study of microbes, their structure and how they develop, grow and reproduce. "Micro" means small, "bio" refers to living organisms, and "ology" stands for "the study of". Microbes are tiny microorganisms containing one cell. Because the number and characteristics of microbes varies, microbiology has been subdivided to include the following specialty areas;

- bacteriology—the study of bacteria
- virology—the study of viruses
- protozoology—the study of protozoa and
- mycology—the study of ***fungi***.

Bacteria

Bacteria are one of the oldest and most common life forms. They can be both useful and harmful. Useful bacteria are more numerous. They cause fermentation, a process necessary for making cheese, vinegar, and beer. Some live in the human digestive tract aiding in food digestion. Harmful bacteria will sour milk and make butter rancid. Harmful bacteria can also cause infections. 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, it can cause infection. Common diseases caused by bacteria include boils, sore throat, whooping cough, blood poisoning, diphtheria, gonorrhea, meningitis, and pneumonia.

Did you know?

One cubic meter of air generally contains around 4,000 bacteria.

Composed of a single, 0.4 - 2 micrometer sized cell, most bacteria lack a nucleus but have a distinct cell wall which contains all the systems and genetic material necessary for growth and reproduction. They are the most versatile of the types of microorganism, being able to function in a variety of environmental conditions. Locomotion is possible in some bacteria through the use of single filament ***flagella***.

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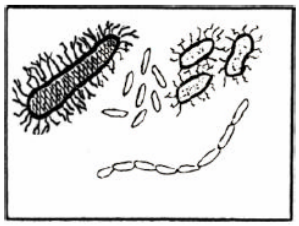
Bacteria require warmth and moisture to survive. If conditions are unfavorable, bacteria can grow a thick shell or casing and go dormant. Bacteria in this state are called ***spores***. Many spores can survive for long periods of time in freezing, boiling, and very dry conditions. This survivability is well-documented. Spores were found in the pyramids of Egypt. Others have been shown to survive exposure to liquid nitrogen (-190 degrees C) for half a year. Since they are the most difficult microorganisms to kill, spores are used to challenge the sterilizer function to ensure that a kill rate is achieved. Spore-forming bacterial infections include anthrax, botulism, gas gangrene, and tetanus.

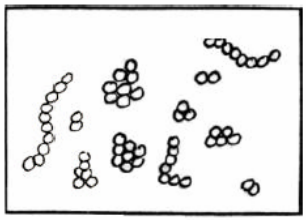
Oxygen plays a significant role in the growth of bacteria. Bacteria that require oxygen for growth are called "***aerobic***". Anaerobes grow only in the absence of oxygen; oxygen is toxic to these microbes. Some bacteria, whether ***anaerobic*** or aerobic, can grow with varying levels of oxygen present.

Bacteria can be classified by their shape, their staining characteristics, and the way they grow.

Bacilli are rod-like. They have large surface areas which help them absorb *nutrients* but it may also cause them to dry out.



Cocci are sphere shaped. They are compact and resist drying.



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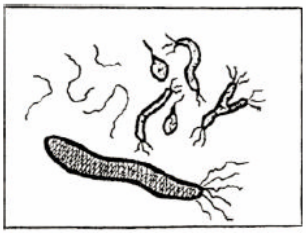
Spirilla are shaped like their name—a spiral. Their corkscrew shape allows them to move about easily.



Bacteria are also classified by their ***Gram Staining*** properties. Bacteria are treated with a special dye, or stain. There are two possible results; Gram Positive bacteria, which appear deep violet blue in color, and Gram Negative bacteria, which appear red in color. Gram Positive bacteria are more susceptible to penicillin, whereas Gram Negative bacteria are usually more susceptible to other antibiotics such as streptomycin. Physicians can use Gram Staining to guide the choice of antibiotic to use.

Virus

Viruses are the smallest and most primitive of infectious agents. Research into viruses is still limited. There are many things we have yet to learn about viruses in order to understand how they produce disease. Studying them is difficult because most cannot be seen with an ordinary microscope. Ranging in size from 20-300 manometers, they are the smallest infectious agent.

Did you know?
Viruses are so small that 5 billion of them could exist in a single drop of human blood.

Viruses survive by invading a living cell. They don't eat, breathe, or grow, and they cannot live on their own. They must have a living ***host*** (most live in the blood). They are inactive outside of a host body, having no way to move on their own, and depend on water, air, or other organisms to move from host to host. They can reproduce rapidly, but only inside a living cell.

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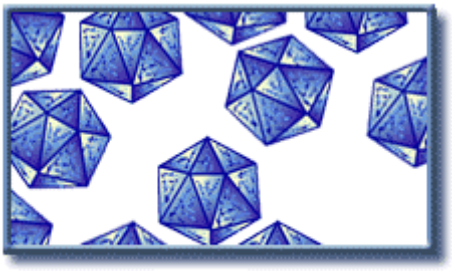
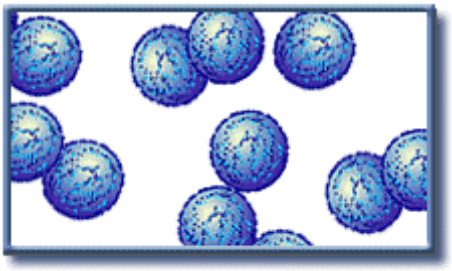
Viruses also come in different shapes:



Crystal

Cylinder



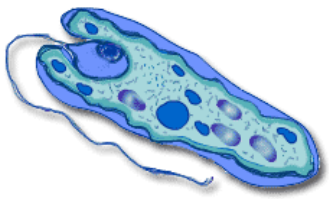
Sphere

Spacecraft

A number of human diseases are caused by viruses, including chickenpox, measles, polio-myelitis, influenza, rabies, hepatitis B, and AIDS. Warts are examples of a virus that is localized. The "flu" is a name given to the Influenza virus.

Viruses do not respond to antibiotics and, because they can reproduce and mutate rapidly, treating them is difficult.

Protozoa



Protozoa are single-celled consumers 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. Protozoa range in size from 1 micrometer to more than 50 millimeters. Being a

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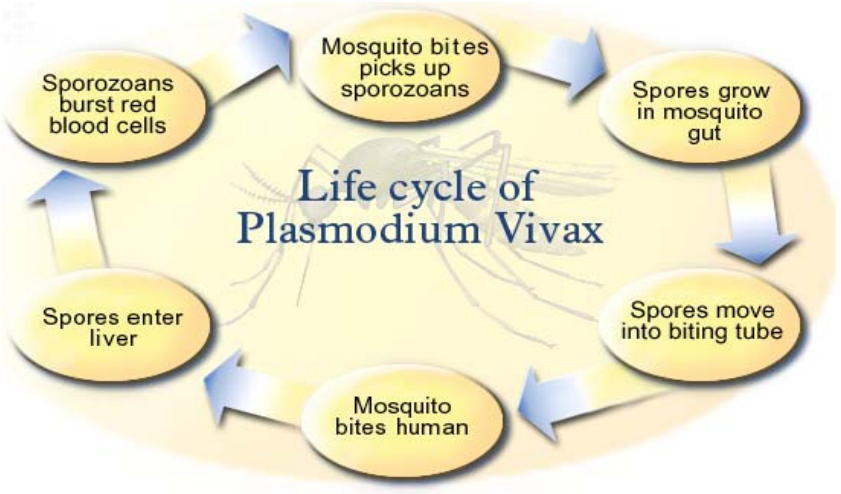
self-contained unit, protozoa are considered to be the lowest form of animal life. They live in blood or water and can be transmitted in a variety of ways.

Examples of diseases caused by protozoa are malaria and amebic dysentery.

Plasmodium vivax is a spore forming protozoa that causes malaria. When a human is bitten by an infected mosquito, the spores enter the liver and form sporozoans that enter the bloodstream where they invade red blood cells, causing them to burst. When a mosquito bites the infected human, it picks up the sporozoans which grow inside it and release spores which infect the next person the mosquito bites.



Rickettsiae

Rickettsiae are small microbes that grow inside a host cell. They are often transmitted in lice or ticks. Smaller than bacteria, but larger than viruses, they have a more complicated structure than a virus. Unlike viruses, they are susceptible to antibiotics.

Examples of rickettsial diseases include Rocky Mountain Spotted fever, Lyme disease, and typhus.

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Fungus

A Fungi may be the most familiar family of microorganisms. They appear in two major forms: molds and yeasts. A fungus is an organism that obtains its food from another organism or from dead organic matter.

Fungus are the largest microorganisms. They can be composed of a single cell, as small as 2 micrometers, or multicellular colonies which are visible to the naked eye. Although there are numerous species of fungi (100,000), only a fraction of these (about 100) are known to cause diseases in humans and animals. Some fungi, like penicillin and mushrooms are useful. Many cheeses and antibiotics are formed using fungi. Others, like the molds that cause ring worm and athlete's foot, can cause problems. Yeasts can cause diseases of the skin, mouth, and genitals.

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 cells are unable to produce their own food through photosynthesis. Lacking this ability, they must 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.

Did you know?

Fungus can reproduce sexually or asexually.
In asexual reproduction the fungus breaks into pieces, with each piece forming a new organism, or forms spores which are small reproductive cells surrounded by a thick protective coating.
Sexual reproduction occurs when two sex cells join to produce spores that grow into a new fungus.

Disease Transmission

It is SPD's job to minimize or eliminate the possibility of any patient or employee acquiring an infection or disease from the use of patient care equipment, instruments, and medical products. ***Disease transmission*** can only occur if six conditions exist:

- an agent that causes it

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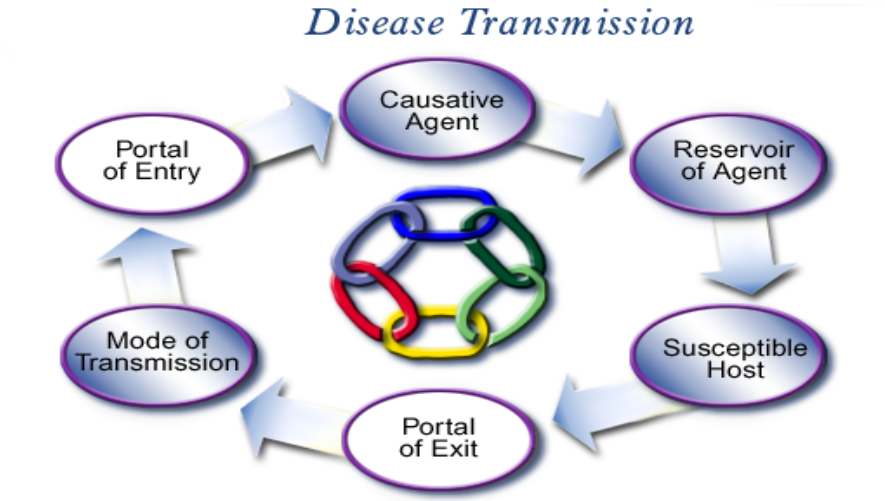
- a place for the agent to live
- a new host that is susceptible to infection
- a portal of exit
- a pathway of transmission
- a portal of entry



If any of these factors are not present, transmission of disease cannot take place. To interrupt disease transmission you only have to break the chain at a single point.

Causitive Agent—The cause of disease is usually bacteria, a virus or, occasionally, parasites. The causative agent is the first link in the chain of infection.

Reservoir of Agent—The reservoir is a place where the pathogen can survive until it can find a suitable host. Reservoirs may be human, animal, or environmental.

Susceptible Host—Even when microorganisms are successful in entering a host body, disease may not develop unless the host is susceptible to the disease and the pathogens are present in sufficient numbers to cause the disease. If the host is not found to be susceptible to infection from the microbe, the organism will simply die. Many things affect how susceptible a host is.

- general health
- good nutrition
- exercise

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- rest
- personal hygiene

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.

The very young and the very old are more susceptible to disease. Also vulnerable are those whose immune systems are already compromised, such as persons with HIV, cancer, or those who are taking immuno-suppressive medications.

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.

Pathway of Transmission

The means by which a microorganism moves from one host to another is called the pathway of transmission. Pathogens are normally transmitted by either direct or indirect contact.

- Direct transmission—contact from one person to another, is the most common mode of disease transmission.
- Indirect transmission occurs when airborne particles, vectors, and ***fomites*** allow microorganisms to move from one place to another.
    - Airborne particles are cast off by persons when they sneeze, cough, laugh, or talk. Particles can be carried for great distances and usually enter a 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

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transferred by flies from the feces of patients to the food that is eaten by otherwise healthy recipients.

- Fomites are inanimate objects which harbor microorganisms and allow them to be transferred from one host to another. Bedding, drinking cups, or patient care equipment are all potential carriers of infection from one person to another in a hospital setting.

Portal of Entry

Pathogenic microorganisms usually invade the body through specific portals of entry. The most common entry points are the respiratory tract, alimentary tract, genitourinary system, and the skin. Generally, 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.

Although the primary disease may not manifest itself when introduced into the body by an alternate entry point, a secondary infection may occur.

Controlling Cross Contamination

Nosocomial, or hospital acquired, infections are infections that a patient acquires while in the hospital. Although only three to five percent of patients entering hospitals develop nosocomial infections, the additional expenses incurred in their treatment amounts to more than one billion dollars each year (statistics from Center for Disease Control). SPD plays a significant role in preventing this type of infection. Every instrument set that is decontaminated and sterilized, and every piece of patient care equipment that is disinfected and re-issued, carries 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.

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There are several basic principles and procedures that were developed to interrupt the transmission of infection and disease.

Proper Hand Washing Procedure

While it may seem like a simple thing, proper hand washing is the most effective weapon against the spread of disease and infection. The Centers for Disease Control define hand washing as a "vigorous, brief rubbing together of all surfaces of lathered hands, followed by rinsing under a stream of water." While soap is often recommended, it is not required and may even cause dry skin and chapping. Some centers have instituted the use of waterless hand cleaning stations in areas where traditional hand washing is not practical.

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 after being contaminated with blood or other body fluids
- after gloves are removed
- before going on and off duty
- before and after meals
- after using the bathroom
- after handling soiled items
- before entering the clean area or handling clean items

Universal Precaution/Standards

Universal Precautions is a concept promoted by the Centers for Disease Control (CDC). It requires that all blood and body fluids be considered potentially infectious, so that they are handled using personal protective clothing and equipment. In the past, personnel exposures to individual cases of disease or infection were controlled through the use of isolation techniques. These specified what type of personal protective equipment and aseptic techniques were necessary in different situations. This approach was complex and sometimes confusing. The isolation approach has been replaced by the concept of Universal Precautions which simplifies the process and avoids mistakes due to confusion or lack of

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information. SPD employees must review training on Universal Precaution/Standards annually.

In 1990, OSHA published the bloodborne pathogen standard, which requires employers to take the necessary steps to reduce the potential for exposure to pathogens during normal working conditions. The goal of this standard is to prevent any blood or other infectious materials from reaching a portal of entry such as an employee's skin, eyes, mouth, or mucous membranes.

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. In compliance with the bloodborne pathogen standard, each SPD technician is offered the Hepatitis B vaccine series at no charge. If the vaccine is refused by an employee, s/he is required to sign a declination statement, which is filed in his/her health records. Employees can change their minds at any time and decide to accept the vaccination.

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. Items which can not be sterilized must be disinfected.

- High-level disinfectants—kill most microorganisms, but not bacterial spores.
- Medium-level disinfectants—effective against many bacteria and viruses, but ineffective against some and will not kill spores.
- Low-level disinfectants—effective only against some bacteria and viruses.

Sterilization Principles

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. Sterilization is a process that destroys all

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microorganisms, including spores, that are present on an object. In SPD, sterilization is normally accomplished by 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.

Remember!

Sterile is an absolute term; either an item is sterile or it is not.

SPD technicians must understand basic Microbiology principles so that they can effectively practice procedures that control, contain, and kill microorganisms. The SPD goal is 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 this goal, SPD must control the number of microorganisms present on medical supplies, instruments, and equipment. Adherence to procedure and observing Precautions/Standards helps to prevent cross-contamination and the spread of disease.

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✓ Check What You Know

1. Match each term to its description or definition.

a. Protozoology	___ Study of parasitic microbes that live in blood or water
b. Virology	___ Study of the smallest microbes
c. Mycology	___ Study of the class of microorganism that includes yeast and mold
d. Bacteriology	___ Study of microbes which produce spores
e. Microbiology	___ Study of one celled microorganisms

2. Match each term to the list of examples.

a. Fungi	___ Pneumonia, blood poisoning, gonorrhea
b. Rickettsiae	___ Mumps, chicken pox, influenza
c. Virus	___ Spotted fever, Lyme disease
d. Bacteria	___ Malaria, dysentery
e. Protozoa	___ Ring worm, athlete's foot

3. Match the following people to their contribution to microbiology.

a. Anton Van Leeuwenhoek	___ Created lenses that allowed humans to view microorganisms
b. Louis Pasteur	___ Created lenses that allowed humans to view microorganisms
c. Robert Koch	___ Pioneered aseptic surgical technique
d. Joseph Lister	___ Discovered that diseases were caused by germs
e. Christian Gram	___ Developed a staining method to classify bacteria
	___ Improved research methods, developed microscope techniques

4. What percentage of patients develop nosocomial or "hospital acquired" infections?

_____

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5. In what situations should SPD technicians wash their hands?

_____

_____

6. What are Universal Precaution/Standards? Why are they important?

_____

_____

_____

_____

7. What is the bloodborne pathogen standard that was published by OSHA in 1990?

_____

_____

8. What is the SPD requirement for the Hepatitis B vaccination?

_____

_____

9. What do you do with an item that can not be sterilized? _____
   a. Throw it away
   b. Clean it with soap and water
   c. Clean it using a chemical disinfectant
   e. Send it back to the manufacturer

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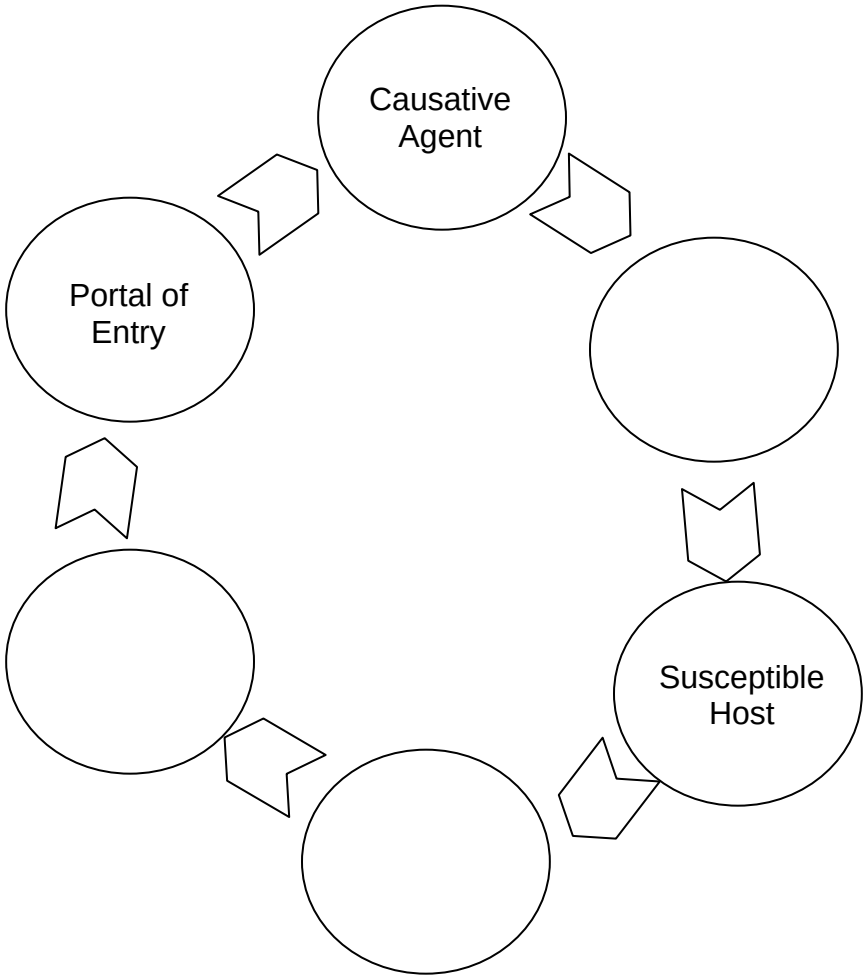
10. Complete the diagram, labeling the stages of disease transmission.



11. A nosocomial infection is _____

_____

_____

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12. Match the modes of disease transmission with their definitions:

a. Direct	___	The most common means of disease transmission, touching someone who is infected
b. Indirect	___	Includes airborne particles, carriers, and inanimate objects
c. Airborne	___	Particles that can be carried great distances, usually entering the body through the respiratory tract
d. Vector	___	Organisms such as mosquitoes, rats, and flies that "carry" disease
e. Fomite	___	Inanimate objects which serve as transfer points

13. What can an SPD technician do to help prevent cross contamination and the spread of disease? _____

a. Follow proper hand washing procedures
b. Observe Universal Precaution/Standards
c. Conform to the requirements of the bloodborne pathogen standard
d. Practice proper disinfection and sterilization procedures

14. How can you prove that something is sterile? _____

a. Examine the label
b. Check the chemical indicator
c. You can't
d. Look it up on the sterilizer log

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Terminology

The following terms were used in this module.

aerobic	living, active, or occurring only in the presence of oxygen
anaerobic	living, active, or occurring in the absence of oxygen
bacteria	a group of sphere-, spiral-, or rod-shaped single-celled organisms
Bacteria-Disease Transmission	to pass or convey an infective agent from one person to another
flagella	a long tapering strand or hair-like tail that extends form the cell wall and is the primary organ of locomotion (flagellum—singular)
fomite	inanimate objects which become contaminated and serve as transmitters of disease (example; glasses, clothing, toys)
fungi	a parasitic spore-producing organism that lacks chlorophyll, including molds and yeasts (fungus—singular)
gram staining	a method of testing bacteria which involves treating them with a coloring solution and observing their coloration
host	a living animal or plant on which a parasite lives
infection control	a process designed to interrupt the chain of infection by reducing the opportunities for transfer of pathogenic microorganisms from one host to another
microorganism	a form of life of microscopic size (too small to see with the unaided human eye)
microscopic	so small or fine as to be invisible without the use of a microscope or other form of magnification
nuclei	the functional center of a cell, it governs activity and

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	heredity of the cell and is essential to cell processes like respiration and reproduction (singular—nucleus)
nutrients	substances which can be used as food
parasites	plant or animal that lives upon or in another living organism
pathogens	a specific agent, such as a virus or bacteria, which cause disease
respirate	to breathe
spores	a resistant body formed within the vegetative cells of some bacteria and fungi, capable of sustaining life in suspended form for long periods of time
sterile	free from all forms of living organisms, especially microorganisms
Universal Precaution /Standards	The practice of Universal Precaution/Standards is to be followed by all healthcare workers whose functions could bring them into contact with blood, body fluids, or body substances. All of the precautions mandate that all contaminated items are treated as if they are known to be infectious. Precautions also include frequent hand washing and the use of PPE.
vector	an organism that transmits a pathogen from one organism to another (example: fleas)
virus	a submicroscopic organism that can only live and grow in a living cell; the causative agent in an infectious disease.

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Module 2 - MICROBIOLOGY

1. CHRISTIAN GRAM DEVELOPED THE MEANS OF STAINING BACTERIA FOR IDENTIFICATION ONTO SLIDES IN THE EARLY 1800'S WHICH IS STILL IN USE TODAY THESE PRINCIPLES MANDATE THAT GRAM POSITIVE ORGANISMS STAIN_____ AND GRAM NEGATIVE ORGANISMS STAIN _____.

A. BLUE, BLUE
B. RED, RED
C. BLUE, RED
D. GREEN, RED

2. THE FATHER OF ANTISEPTIC SURGERY WAS WHICH OF THE FOLLOWING?

A. LOUIS PASTEUR
B. KARL VAN WHOOSEN
C. JOSEPH LISTER
D. CHRISTIAN GRAM

MATCH THE FOLLOWING TERMS WITH DEFINITIONS:

A. STUDY OF VIRUS B. STUDY OF PROTOZOA
C. STUDY OF BACTERIA D. STUDY OF FUNGI
E. STUDY OF MICROBES

3. MYCOLOGY IS THE

A. A
B. B
C. C
D. D
E. E

4. PROTOZOOLOGY IS THE

A. A
B. B
C. C
D. D
E. E

5. VIROLOGY IS THE

A. A
B. B
C. C
D. D
E. E

6. THE OLDEST AND MOST COMMON FORM OF LIFE IS?

A. FUNGI
B. VIRUSES
C. PROTOZOA
D. BACTERIA

7. BACTERIA THAT HAVE GROWN A THICK SHELL OR CASING AND HAVE GONE DORMANT ARE KNOWN AS WHAT?

A. FUNGI
B. VIRUSES
C. SPORES
D. PROTOZOA

8. BACTERIA THAT REQUIRE OXYGEN FOR GROWTH AS SAID TO BE?

A. ANAEROBIC
B. AEROBIC
C. AIR BREATHERS
D. PROTOZOA

9. THE MOST PRIMITIVE AND SMALLEST OF INFECTIOUS AGENTS ARE CALLED?

A. FUNGI
B. VIRUSES
C. BACTERIA
D. PROTOZOA

10. VIRUSES MUST HAVE A LIVING ORGANISM TO LIVE AND MOVE. THESE SURROGATE ORGANISMS ARE KNOWN AS?

A. VIRUSES
B. PROTOZOA
C. HOSTS
D. COMPANION

11. THE FIRST LINK IN THE CHAIN OF INFECTION IS?

A. PORTAL OF ENTRY
B. VECTOR
C. THE CAUSATIVE AGENT
D. HOST

12. THE BODY SYSTEM THAT HELPS THE HUMAN BODY FIGHT DISEASE IS?

A. RESPIRATORY
B. DIGESTIVE
C. LYMPHATIC
D. ENDOCRINE

13. THE MEANS BY WHICH MICROORGANISMS MOVE FROM ONE HOST TO ANOTHER IS KNOWN AS?

A. PATHWAY OF TRANSMISSION
B. PORTAL OF ENTRY
C. OSMOSIS
D. INFECTION

14. SPD BREAKS THE DISEASE TRANSMISSION CYCLE THROUGH?

A. BRING DIRTY INSTRUMENTS TO SPD IN OPEN CONTAINERS
B. WASHING THEIR HANDS ONLY AFTER EATING
C. HAVING COFFEE IN THE PREP ROOM
D. PROPER INFECTION CONTROL PROCEDURES

15. THE MOST EFFECTIVE WEAPON AGAINST THE SPREAD OF DISEASE AND INFECTION IS?

A. WEARING THE PROPER PPE
B. HAND WASHING
C. SHOWERING AT THE END OF EACH SHIFT
D. HAVING A DEDICATED PAIR OF SHOES FOR SPD

16. SPD PERSONNEL SHOULD ALWAYS WASH THEIR HANDS AFTER ALL OF THE FOLLOWING *EXCEPT*?

A. BEING EXPOSED TO BLOOD OR BODY FLUIDS
B. AFTER USING THE BATHROOM
C. BEFORE ENTERING SPD
D. AFTER PUTTING ON GLOVES

17. TRUE OR FALSE STERILIZATION IS AN ABSOLUTE IT IS EITHER STERILE OR IT IS NOT!

TRUE - FALSE

18. A PROCESS THAT KILLS ALL MICROORGANISMS TO INCLUDE SPORES IS KNOWN AS?

A. DISINFECTION
B. ANTI BACTERIAL
C. STERILIZATION
D. ANTIMICROBIAL

19. A PROCESS THAT KILLS MOST MICROORGANISMS BUT NOT SPORES IS KNOWN AS?

A. STERILIZATION
B. LOW LEVEL DISINFECTION
C. MID LEVEL DISINFECTION
D. HIGH LEVEL DISINFECTION

20. A PROCESS THAT IS ONLY EFFECTIVE AGAINST SOME BACTERIA AND VIRUSES IS KNOWN AS?

A. STERILIZATION
B. LOW LEVEL DISINFECTION
C. MID LEVEL DISINFECTION
D. HIGH LEVEL DISINFECTION

Section Three: Decontamination

Estimated Contact Time: **45 minutes**

This module covers:

…decontamination, the critical first step in maintaining infection control. Decontamination is the process of cleaning and disinfecting medical supplies and equipment. Based on the premise that all items are contaminated and potentially infectious, the decontamination process plays a vital role in interrupting the transmission of infectious disease. In this module you will learn about: the purpose of decontamination, the procedures and equipment used, collection and transportation requirements, and the role of decontamination in infection control.

Following instruction, you should be able to perform the following:

- ☑ Identify the purpose of decontamination.
- ☑ Detail infection control procedures that are necessary in the decontamination process.
  - Identify Personal Protection Equipment.
  - Identify guidelines for safely handling sharps.
  - Identify hand-washing requirements.
  - Identify procedures for handling spills, soiled laundry and infectious waste.
- ☑ Detail collection and transportation requirements.
- ☑ Identify decontamination equipment, procedures, and precautions.
  - Identify equipment.
  - Detail equipment purpose.
  - Describe equipment operating procedures.
  - List precautions/exclusions for each piece of equipment.

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Why is Decontamination Important?

One of the primary concerns of a medical facility is infection control. The medical center staff must follow specific precautionary steps to minimize the spread of pathogens from one patient to another. Supplies, instrumentation, and equipment must be clean and/or sterile, and the procedures for collecting, processing, and handling them must be designed to control the spread of the microbes that can cause infection and disease.

Decontamination is the process of decontaminating or purging medical devices of fluid and debris that might harbor living organisms. By cleaning and disinfecting the surface of medical devices, you reduce the bioburden, decreasing the chance that microorganisms will find a place to live and grow. Devices cannot be sterilized unless the bioburden is low enough for the sterilization agent to come in contact with all surfaces and kill the microorganisms.

By eliminating pathogens from the surface of medical devices, decontamination plays a vital role in interrupting the transmission of infectious disease.

The decontamination area must be separated from the rest of SPD in order to isolate soiled items during processing. To work in this area you must be trained in the specific processing methods.

Decontamination Area Requirements

The decontamination area is specifically designed to meet the medical center's needs for the processing of supplies and equipment.

- It is a restricted area and should be physically separated from the rest of the SPD areas.
- The area must have adequate lighting to allow for inspection of articles during processing.
- Ventilation must be under negative pressure, allowing air to be pulled from areas outside of decontamination. This reduces cross contamination into surrounding areas.

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- Wall, ceiling, and floor surfaces must be designed to withstand daily cleaning with a disinfectant to reduce the bioburden or microorganism count in the area.
- Transportation of supplies and equipment to decontamination must be in impervious bags, impervious covered/closed carts, cart lifts, dumbwaiters, and automated transport systems.
- 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.
- The area must allow direct access to user areas, such as surgery and the wards, so that contaminated materials can be quickly and efficiently transferred. The longer material remains dirty, the more opportunities there are for cross contamination.

Protective Equipment

Personal protective equipment (PPE) is essential to an SPD technician's safety. As a technician, it is your responsibility to understand the policies and procedures regarding protective attire in each work area or job assignment. It is the medical center's responsibility to provide healthcare workers with PPE and training to promote personal safety.

Reference: http://www.cdc.gov/ncidod/hip/isolat/isopart2.htm

Since the introduction of Universal Precaution/Standards, all used equipment and supplies must be treated as if they are contaminated. Protective attire must be donned before entering the decontamination area. Ideally, an area immediately outside the decontamination area should be available for this purpose.
The type of PPE used in SPD includes:

- surgical scrub suits
- surgical hair covers

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- impervious gown
- impervious shoe covers
- face mask and goggles or face shield, designated decontamination gloves (not exam gloves)
- Additional protective items include plastic aprons and ear protection. (Ear protection may be necessary when some equipment is in use.)

Personal protective equipment must be stored outside of the decontamination area, donned before entering, worn at all times in the decontamination area and removed whenever you leave the area. After removing protective wear, you must wash your hands. A shower is highly recommended at the completion of duties in decontamination. 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. PPE should be stored in an area away from contaminated equipment.

Head/hair cover

A non-impervious bouffant hat must be worn to contain hair and cover the top and sides of the head. Workers with facial hair should also wear a face mask or full face shield.

Glasses/goggles/face shield

A reusable face shield, which covers from ear-to-ear and below the chin, is the preferred protection against splashing liquids. Goggles and a surgical mask are acceptable substitutes. Goggles and shields should be cleaned regularly.

Decontamination gloves

Decontamination or high-risk gloves must be worn. They may be reusable, but must be assigned to the individual employee, who is responsible for keeping them cleaned. Gloves must be long enough to come up over the cuff of the gown. (*Do not wear surgeon's or exam gloves under the decontamination glove. Cloth liners are available for those who are allergic to the glove material.)

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Gown

A long-sleeved, fluid-impervious gown or jumpsuit is required. It should cover from neck to knees and may be disposable or reusable. It must be worn properly and tied.

Shoe cover

Shoe covers must be fluid-impervious and reach to mid-calf.

PPE for collecting contaminated materials is designed to protect you and others that you may come in contact with.

Cover Gown

A cover gown is a long-sleeved, fluid-repellant garment (which may be open in the back), used to protect the uniform from soil. The cover gown must be removed when pick-up duties are complete.

Exam Gloves

Exam gloves are to be donned prior to handling any contaminated items or containers. They must be changed after each pickup in each separate ward or floor location. To avoid contaminating surfaces in public areas, gloves should not be worn while transporting contaminated items back to the decontamination area.

Detergents and Disinfectants

Detergents and disinfectants are the chemical agents used in 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. A disinfectant or detergent should always be used for what it is intended. If used properly, the solution will perform effectively. As an SPD technician, you are responsible for knowing the types of detergents and disinfectants available for use and the manufacturer's instructions for using them. Make sure you have reviewed the Material Safety Data Sheet (MSDS) for any chemical

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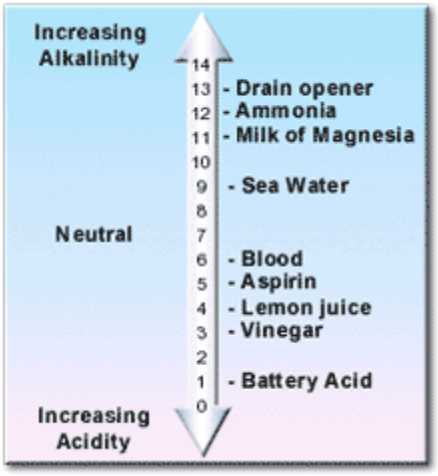
before you use it. Misuse could cause harm to both you and the patient.

Detergents

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 microorganisms a place to live and colonize (grow in numbers). Instrumentation and equipment that is not properly cleaned will continue to harbor microorganisms and may impede the disinfection and/or sterilization process.



Detergents are selected based on their pH level. Ph is a measure of how acidic or alkaline a substance is.

- 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.

The pH scale is logarithmic. That means that each mark on the scale represents a tenfold change. For example, lemon juice is ten times more acidic than vinegar. And battery acid is one hundred times more acidic than vinegar (10X10).

Did you know?

The pH abbreviation stands for “Potential of Hydrogen” or how likely a substance is to give up hydrogen atoms when mixed with water.

Detergents are used in both manual and mechanical decontamination processes. They can be used with:

- Ultrasonic
- Pasteurmatic washer
- Cart washer
- Washer/sanitizer
- Washer/sterilizer

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- Manual processing/presoaking of instruments

Disinfectants

Disinfectants are substances that inhibit/destroy the growth of pathogenic microorganisms. They may have little or no effect on bacterial spores. Disinfectants can be classified as high-, medium-, or low-level, according to their ability to kill microorganisms.

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Type:	Kills:	Appropriate for:	Examples:
High Level	all bacteria, viruses, and fungi, but not bacterial spores.	items that may have come into contact with body tissue. also as an appropriate means of disinfecting items that come in contact with mucous membranes (respiratory devices, laryngoscope blades, EGD, colonoscopes).	chlorine dioxide, hydrogen peroxide, and peracetic acid-based formulation
Medium Level	most pathogenic microorganisms and some viruses. They do not kill bacterial spores.	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.	chlorine compounds, alcohols (70 percent to 90 percent ethanol or isopropyl), and some phenolic and iodophor compounds
Low Level	some types of bacteria They generally have little effect on viruses and do not kill spores.	use in cleaning environmental surfaces, such as table tops, floors, and walls.	chlorine compounds (bleach or Sodium Hypochlorite), alcohols (70 percent to 90 percent ethanol or isopropyl), and Quaternary Ammonium Compounds

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Collection and Transport Systems

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.

All nursing units and clinic areas should have a dedicated soiled utility or "dirty" room. SPD will provide enclosed carts or containers in these rooms for the collection of all ward procedure trays and reusable devices. 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.

Gloves must be changed after direct handling of contaminated items and between container drop-off sites. This will help reduce the chance of cross contamination between soiled pickup points and public conveyance (i.e., elevator buttons, door handles, telephones).

Take care to protect the environment when transporting contaminated items to SPD. Always cover contaminated items prior to transportation to SPD for decontamination. This prevents cross contamination to areas in the healthcare facility. There are several types of collection systems that can be used to transport items to the decontamination area:

Solid Containers

Solid containers provide an excellent barrier to cross contamination, as well as protection for the SPD technician. Containers 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.

Carts

Carts used for soiled collection and transport should be:

- Easy to maneuver

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- Easy to clean and decontaminate
- Made of metal or plastic
- Closed or covered with an impervious covering (A combination of a cart and a container is often used for soiled pickup.)
- Solid bottomed
- Dedicated for that purpose. (They may not be used for any other tasks.)

Carts require regular maintenance to keep them in peak working order. They should be cleaned daily or more often if needed. Cart wheels must be lubricated to ensure that they roll freely.

Specialty carts should be cleaned after use. Unused, single-use and disposable items must be removed from the specialty cart prior to taking it into the decontamination area for unloading and cleaning. If the items are taken into the decontamination area, they must be considered contaminated and discarded since they cannot be reprocessed.

When transporting large equipment such as emergency carts, warming blankets, etc., plastic bags are required if the item has come into contact with blood or body fluids.

Automated Transport Systems

An automated transport system consists of a series of enclosed carts, guide tracks, and dedicated elevators, enabling contaminated material to be picked up on a preprogrammed schedule. A technician programs the desired pickup points and intervals into the system. At the appointed times, the system retrieves the loaded carts and transports them to SPD for processing.

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

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designated area, automatically loads the waiting cart, and automatically returns it to the SPD decontamination area. These systems lessen human exposure to contaminated materials and reduce the manpower required for collection.

Dedicated Lifts/Dumbwaiters

Dedicated lifts provide a direct route to SPD for contaminated materials. This simplifies the collection process and reduces the opportunities for cross contamination.

Carts and dumbwaiters must be designated as either clean or dirty—they are not interchangeable. Regular weekly cleaning and disinfection are necessary for proper infection control.

The Decontamination Process

Decontamination is the process performed to protect patients from the risk of infection caused by the use of reusable devices. The purpose of the Decontamination Area is to clean and disinfect all reusable supplies and equipment in order to reduce the bioburden. It is critical that all soil be removed and the surface treated with the appropriate disinfectant.

Items are collected from the user areas and transported to the decontamination area. As items are unloaded, they should be inspected to ensure that they are in good condition and that all parts are accounted for. If something is damaged or missing, you must record where the items came from and notify the user. Because of the number and variety of items used in the medical center, items should be sorted based on the processing method that they require.

The types of items to be cleaned include:

a. Electrical equipment
b. Non-electrical equipment
c. Rubber/plastic supplies
d. Surgical instruments

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e. Metalware

f. Glassware

g. Surgical power equipment

h. Endoscopic equipment

i. Other

Regardless of the instrument or equipment, the purpose of decontamination is the same; you want to remove substances that might harbor microbial life from the surface to reduce the bioburden. You reduce the bioburden as low as possible to allow for safe use and sterilization.

In general you do this by:

- Removing visible tissue or bone (gross soil)
- Cleaning the device, mechanically or by hand
- Applying the appropriate disinfectant
- Allowing the item to dry

The following are basic cleaning processes for each type of equipment.

Directions for Cleaning
ELECTRICAL EQUIPMENT

Examples: *infusion pumps, feeding pumps, K-pad motors, air compressors, portable suction machines, hypothermia units*

1. Use a cleaning cloth saturated in disinfectant solution.
2. Start at the top and work down.
3. Wipe all exposed surfaces.
4. Use a brush to clean nooks and crannies.
5. Wipe the electrical cord; inspect it for damage; coil it up and secure it with a binder.
6. Wipe your work surface before turning the equipment over to work on the underside.
7. Wash casters and wheels last.

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To prevent cross contamination, always rinse cloth in disinfectant solution between cleaning pieces of equipment.

Directions for Cleaning
NON-ELECTRICAL EQUIPMENT

Examples: *IV poles, wheelchairs, litters, K-pads, hypothermia blankets, seizure pads, foot cradles, commodes, isolation carts*

1. Use a cleaning cloth saturated in disinfectant solution.
2. Start at the top and work down.
3. Wipe all exposed surfaces.
4. Use a brush to clean nooks and crannies.
5. Wipe the electrical cord; inspect it for damage; coil it up and secure it with a binder.
6. Wipe your work surface before turning the equipment over to work on the underside.
7. Wash casters and wheels last.

Directions for Cleaning
RUBBER AND/OR PLASTIC SUPPLIES

Examples: *nasal airways, oral airways, reusable ventilator tubing, reusable resuscitators, pulmonary tubing*

1. Inspect each piece for tears, holes, or deterioration.
2. If using a washer/sterilizer, washer/sanitizer, or pasteurization machine, place items in the appropriate basket insert before starting cycle. Baskets are needed to correctly position the items to ensure that they get clean.
3. Pre-clean heavily soiled items prior to mechanical processing.
4. Use small brushes to clean inside tubes; rinse thoroughly.
5. Dry using compressed air, a tube drier, or allow to air-dry in the appropriate position.

Do not attempt to use the sonic cleaner for rubber or plastic items. They will absorb the sonic waves.

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Directions for Cleaning
SURGICAL INSTRUMENTS

Examples: *forceps, hemostats, saw blades, scissors, retractors*

1. Open or disassemble instrument.
2. Rinse the instrument with water and remove any gross soil. Inspect the teeth and grooves for tissues or bone fragments.
3. Remove debris by holding the instrument under the surface of the solution and scrubbing the area with an instrument brush.
4. Place the instruments in an ultrasonic cleaner, or hand wash items such as bone rasps and roungers, if necessary. Process instruments in small batches to avoid tangling and damage. Handle instruments so that you avoid damage to the instrument or injury to yourself.
5. Pay particular attention to cannulated items or items with lumens. They may harbor blood and body tissue. Soak in hydrogen peroxide, if necessary, to loosen debris and use a small brush to ensure that all debris is removed.

Extreme care should be taken when handling sharp items. Scalpel blades, disposable needles, saw blades, and drill points should be disposed of by the operating room staff, but may be inadvertently overlooked.

Splashing is likely during this activity. Eye protection and a mask are required.

The type of instruments that will pass through SPD's decontamination area depends on the services offered at a medical center or clinic. Instruments are a costly investment; proper handling will extend the useful life of the investment. Handle them in small groups to avoid tangling and damage, and always place them in an open position to allow all areas to be exposed to the cleaning process. Needles should be separated and processed separately.

Use only nonabrasive cleansers to clean instruments because 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 high pH level (alkaline) or low pH level (acidic) may damage the surface of the instrument.

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Directions for Cleaning
METALWARE

Examples: *bedpans, basins, medicine cups, instrument containers*

1. Remove gross soil by manual washing.
2. Inspect items for damage.
3. Load items so that they will be correctly positioned during processing. Metalware with open depressions should be positioned open end down to facilitate drainage.
4. Use basket inserts to keep items from moving around during cleaning. Movement can damage the items, chamber, or spray arms.

If an item fills with water during processing, use extreme caution during removal. This represents a burn hazard, and protective gloves are required.

Directions for Cleaning
GLASSWARE

Examples: *syringes, medicine cups, elik evacuator, straight and Y connectors, graduates*

1. Disassemble component parts.
2. Inspect each item for cracks and chips.
3. Use appropriate brush and detergent to pre-clean lumens.
4. Needles must be soaked in hydrogen peroxide **first** and then processed.
5. Process in washer/sterilizer/sanitizer.
6. Remove items and inspect for damage.

Care must be taken when handling glassware. Broken glass can cause a serious wound to staff or patient.

Scrubbing must be done under the surface of the solution; eye protection is mandatory.

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Directions for Cleaning
SURGICAL POWER EQUIPMENT

Examples: *drills, saws, reamers, mini drivers, compressed air/nitrogen powered equipment*

1. Remove the hose and inspect for damage. Handpieces should be attached to the hose during cleaning to prevent solutions from entering the motor.
2. Wash the hose in a mild detergent. Do NOT use saline or a disinfectant solution.
3. Wipe off the hand piece with a mild detergent, followed by wiping down with a water-dampened cloth.

Although it is the user's responsibility to remove cutting blades or drill bits, this equipment may be returned 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.

Use care to avoid getting the cleaning solution or water inside the hand piece.

Directions for Cleaning
ENDOSCOPIC EQUIPMENT

Examples:
Rigid endoscopes: arthroscopes, cystoscopes, bronchoscopes, laryngoscopes
Flexible endoscopes: sigmoidoscopes, colonoscopes, bronchoscopes, laparoscopes, cystoscopes

Rigid Endoscopes

To manually process a rigid endoscope:

1. Remove the fiber optic light cable from the scope.
2. Check the scope for damage, such as clouded lenses, bent instrument shaft, and burrs on the tip of the instrument shaft.
3. Remove the fiber optic light cable from the scope.
4. Wipe down scope, light cables, and adapters using appropriate cleaning solution.
5. Thoroughly rinse items by wiping down with a water-dampened cloth.
6. Careful attention should be paid to the lenses—they should be wiped with an alcohol-dampened swab/applicator.

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7. Dry the scope thoroughly using a soft, lint-free cloth.

Before processing any scope, the technician should consult all manufacturer's instructions.

NEVER handle the scope by the shaft because it may cause damage.

Flexible Endoscopes

Flexible endoscopes can be used by a variety of services within the medical center, such as GI, Procto Clinic, Respiratory, Surgery, and ENT Clinic.

Manual processing:

1. Remove caps and/or valves on scope.
2. Using an enzyme solution, brush the channel(s) and flush until completely clean.
3. Hook up scope to leak tester to check integrity of the channel(s).
4. Inspect the outer casing of the scope.
5. If no damage is detected, process in a disinfecting solution. Scopes that are terminally sterilized in EtO do not need to be processed in a disinfecting solution, such as glutaraldehyde.
6. Rinse and dry. (Prior to storage all channels must be dry. Compressed air or 70% alcohol may be used to dry the channels.)
7. Test the scope to ensure that all features work properly.

Automated Cleaning/Disinfecting:

Follow the manufacturer's instructions for specific scopes and scope washers.

1. Manually clean the scope.
2. Select the appropriate adapter and attach it to the open channels. Selection of the correct adapter is critical.
3. Process scope, allowing cleaning solution to penetrate.
4. Rinse, dry and test as above.

After disinfecting, the scope is passed through to the preparation area for further processing.

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Directions for Cleaning
OTHER ITEMS

Examples: *bovies, pacemaker cords, defibrillator paddles, EMG needles, EKG leads, rectal probes*

General cleaning procedures are as follows:

- Inspect the outer case of the device for cracks, tears, or deterioration.
- Prepare a disinfectant 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.
- Allow device to air-dry and then send it to the preparation room.

Microsurgical and delicate eye instruments
Delicate instruments should not be processed through a washer/sterilizer because the turbulent action of steam mixed with water may cause damage. They should be hand cleaned or processed through the ultrasonic in a protective cassette, rinsed, dried, and processed on a sterilize cycle only to ensure a decreased bioburden.

Mechanical Equipment

There are several types of equipment in the Decontamination area that are designed to help you process instruments and equipment. Each is designed to process a select group of instruments or equipment. The cleaning method you use will depend on the size and shape of an item, what it's made of, and how it's used, and the manufacturer recommendations.

Ultrasonic Cleaner

The Ultrasonic Cleaner is designed to clean surgical instrumentation using 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 other difficult to clean areas.

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The ultrasonic cleaner uses sound waves to vibrate the cleaning solution. Microscopic bubbles form on the instrument surface. As the bubbles implode they produce a vacuum area that dislodges minute particles of debris. This process is called cavitation.
The cleaning solution used in the ultrasonic should be changed whenever visibly soiled or at least once or twice per shift. The number of solution changes is proportional to the number of sets processed.

Did you know?

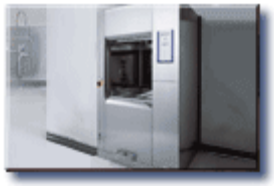
The ultrasonic cleaning process is based on a fairly simple physical principle. Sound travels in waves that cause surrounding molecules to move back and forth in the direction of the wave. The higher the frequency, the faster the molecules move. In an ultrasonic cleaning chamber, the sound waves vibrate the cleaning solution with such intensity that the liquid molecules begin to pull apart. This produces air bubbles (much like boiling water) on the surface of the item being cleaned. When the bubble collapses it creates a void or cavity and surrounding molecules rush in to fill the space. This 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.

Utensil Washer

The Utensil Washer 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 such as pre-rinse and de-ionized or distilled water rinses may be available. Only items designed for this unit should be processed in it. All items should be inspected following the cycle to ensure that they are clean.

Washer/Sanitizer



The Washer/Sanitizer is designed to wash and sanitize. For the sanitizing process, hot water or steam at atmospheric pressure is injected into the chamber to kill microorganisms on item surfaces. The washer/ sanitizer uses hot water at 60-95 degrees Celsius. It thermally disinfects but does not sterilize. It is used for a

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wide range of items that may deteriorate under the high temperature of the washer/sterilizer.

Sanitization is less effective in killing microorganisms than a washer/sterilizer.

Washer/Sterilizer

The Washer/Sterilizer uses saturated steam at a temperature range of 121-140 degrees Celsius. It is designed to clean and sterilize in four cycles: wash, rinse, sterilize, and exhaust.
It can process metalware, surgical instruments, and glassware. Ideally, demineralized or de-ionizer 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 ensure the instruments will dry completely and not emerge into the prep room wet after the cycle.

Check monitoring displays throughout the cycles to ensure that the machine is functioning properly. A machine that does not perform up to standard will not properly process the load.

CAUTION!

Stainless steel instruments should not be processed close to instruments made of metals, such as non-anodized 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.

Pasteurmatic Washer

The pasteurmatic uses hot water at 170 degrees (76.7 degrees C) to clean and disinfect plastic/rubber tubing and similar items. The cycle lasts for 30 minutes. This process is not effective against spore-forming bacteria.

Scope Washer

The scope washer is a machine used to automatically clean and disinfect flexible endoscopes. Depending on the unit, there may be

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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 and 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, you should review the manufacturer's operating instructions.

Cart Washer

The cart washer, as the name implies, is used to clean items such as carts, wheel chairs, litters/stretchers, and metal pan ware. The 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.

Steam Cleaning Device

The steam cleaning device (commonly called a steam gun) is a handheld device used for sanitizing items such as wheelchairs, litters, and carts. Steam cleaning devices can come equipped with detergent dispensers and water rinse options.

CAUTION!

Use caution when using this device. Splashing or burns may occur if personal protective equipment is not used.

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Tube Dryer

The Tube Dryer is used to dry plastic or 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, you must check the items to ensure they are completely dry. Items that are not dried correctly may interfere with further thermal or EtO sterilization.

As an SPD technician, you are faced with the task of cleaning and disinfecting a wide variety of instruments and equipment. It is critical that you become familiar with them and follow manufacturer's directions for cleaning and disinfecting them. Procedures for cleaning equipment are kept on file within SPD. You are responsible for knowing where they are and using them whenever you have questions or are unsure. By applying the appropriate cleaning process and using disinfectants correctly, you prevent cross contamination and accomplish the most critical step in the infection control process.

Remember…

This equipment is expensive and some of it is very delicate. Improper cleaning can render it useless and may affect patient care.

Infection Control

Universal Precaution/Standards should be strictly followed in the decontamination area. It is your responsibility to be familiar with the policies and procedures that govern your work area.
The following guidelines are critical in controlling the spread of infection.

- Wear Personal Protective Equipment.
- Use proper hand washing technique.
- Follow procedure for handling spills and soiled material.
- Practice safe handling of sharps.
- Clean all environmental surfaces on a regular basis.

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Personal Protective Equipment

PPE was discussed earlier in this module. It helps to protect you, the environment, and the patients and visitors in the medical center.

Hand Washing

Hand washing is the single most important step in preventing cross contamination. You should wash your hands before and after every task, including:

- Before starting work
- Before and after meals or breaks
- After using the bathroom
- After handling soiled items
- Before entering clean areas to handle clean items
- Before going off duty
- Immediately following unanticipated contact with body fluids or chemicals

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.).

Soiled Materials

Reusable materials, such as towels, instruments, and equipment, which have come in contact with body fluids, should be handled as little as possible. Place materials in an appropriate moisture-resistant laundry bag and carry them to the proper location for cleaning and decontamination. Be sure to wear personal protective clothing while handling them.

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.

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Impervious disposal containers with secure fitting lids should be provided in the decontamination area. Containers should be emptied and disinfected regularly by Environmental Management Service.

Safe Handling of Sharps

Sharps are defined as: needles, scalpel blades, and other sharp objects that can penetrate the skin. Safe use includes:

- Inspecting procedure trays carefully for sharps that have not been disposed at point of use.
- Immediate disposal in a puncture-resistant container
- Using forceps to remove a scalpel blade from a reusable handle
- Never picking up broken glassware with your hands
- Never putting your hands in a sharps container to retrieve items
- Never placing sharps in uniform pockets or using them for other purposes such as opening boxes or removing tape.

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.

Safety

The SPD Policy and Procedures Manual provides safety related guidelines for technicians to follow. It is the technician's responsibility to know and observe safety rules.

Material Safety Data Sheets (MSDS) are documents (prepared by the manufacturers of chemical products) provided to users so they understand the safe use of the products. The MSDS usually consist of 8 to 10 sections of information regarding health hazards, emergency procedures, precautionary measures, and first aid techniques. SPD must have a copy of the MSDS for each chemical

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that is used. You must review the MSDS before handling any potentially hazardous chemicals.

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

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 include:

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. Equipment noise.

Summary

Decontamination is the first and most critical step in the process of making medical devices germ free. It is dirty, time-consuming, repetitive work that is absolutely essential to the infection control process. The nature of the work demands that the technician perform, without error, in an uncomfortable, hazardous environment, often under time constraints. The decontamination tasks require knowledge of procedures, operation of multiple types of equipment, and attention to detail.

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✓ Check What You Know

1. The purpose of decontamination is to: _____
    a. Protect workers
    b. Ensure the sterility of surgical devices
    c. Reduce the bioburden on reusable devices
    d. Facilitate cross contamination

2. Match each term to its description.

a. Low-level disinfectant	___	Aids removal of soil such as blood, pus, and urine
b. Detergent	___	A measure of the acidity or alkalinity of a substance
c. High-level disinfectant	___	Appropriate for items that will come in contact with body tissues or fluids or mucous membranes
d. pH level	___	Used for cleaning environmental surfaces such as walls and floors
e. Medium-level disinfectant	___	Kills most pathogenic microorganisms and some viruses

3. Match each term to the correct statement.

a. Solid containers	___	Wheels require routine lubrication
b. Carts	___	Must have a tight fitting lid
c. Dumbwaiters	___	Requires programming by a technician
d. Automated Transport	___	Must be designated as either clean or dirty

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4. Which statements are true regarding the collection of contaminated items?
   ____ a. PPE consists of gloves and a head covering.
   ____ b. Containers must be made of disposable material.
   ____ c. Is done on an "as-needed" basis.
   ____ d. Must be done in a manner that protects the technician, the environment, and the public.

5. Which of the following can be processed in a washer/sterilizer? _____
   a. Flexible endoscope
   b. Metalware
   c. Surgical power equipment
   d. Glassware

6. Order the steps for decontaminating surgical instruments.
   ____ a. Place on trays or washer racks in open position.
   ____ b. Remove gross soil.
   ____ c. Process in ultrasonic cleaner.
   ____ d. Send to prep room.

7. Order the steps for decontaminating power tools.
   ____ a. Remove bits or blades.
   ____ b. Wipe hand piece with water-dampened cloth.
   ____ c. Remove power source.
   ____ d. Clean hand piece with cleaning solution.

8. Which statements that are true regarding sharps?
   ____ a. Disposable sharps should be disposed of at the point of use.
   ____ b. Sharps are not a concern for SPD. They are disposed of by the user.
   ____ c. Sharps must be disposed of in special containers.
   ____ d. Sharps generally are reusable and must be reprocessed with care.

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Terminology

The following terms were used in this module.

bioburden	The amount of contaminants on a surface.
bacteria	A group of round-, spiral- or rod-shaped single-celled organisms.
cannulated	Having a small tube designed to be inserted into a body cavity, duct, or vessel.
cavitation	The principle of action upon which ultrasonic cleaning is based.
contaminated material	Material that has come into contact with blood or other body fluids and may harbor infectious microorganisms.
electrolysis	The producing of chemical changes by the passing of an electrical current through a substance.
fungi	A parasitic spore-producing organism that lacks chlorophyll, including molds and yeasts.
germicide	An agent that destroys or kills germs.
gross soil	A concentration of organic matter such as pieces of tissue or bone adhering to surgical instruments or medical equipment in sufficient quantities to contaminate the environment. Blood is not considered to be gross soil.
impervious	Able to prevent the passage of fluids.
infection control	A process designed to interrupt the chain of infection by reducing the opportunities for transfer of pathogenic microorganisms from one host to another**.**
lumen	The cavity of a tubular organ, the bore of a tube, such as a catheter.

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microorganism	A living being of microscopic size.
Pasteurmatic	Uses hot water at 170 degrees F for 30 minutes to clean plastic and rubber tubing.
Personal Protective Equipment (PPE)	Attire that is designed to keep workers safe form environmental hazards; PPE may vary according to the work assignment**.**
pH level	A measure of how acidic or alkaline a substance is—neutral pH equals 7 on a 0-14 scale.
point-of-use	The location where an instrument or device is used for its intended purpose. For example, the operating room would be the point-of-use for surgical instruments.
sharps	Needles or other sharp instruments that must be handled with caution and disposed of properly.
specialty carts	Carts stocked with supplies designated for a specific procedure or activity.
Ultrasonic Cleaner	Device that uses sound waves to remove particles from objects in a water bath through a process called cavitation.
Universal Precaution/ Standards	The practice of Universal Precaution/Standards is to be followed by all healthcare workers whose functions could bring them into contact with blood, body fluids, or body substances. All of the precautions mandate that all contaminated items are treated as if they are known to be infectious. Precautions also include frequent hand washing and the use of PPE.
virus	A submicroscopic organism that can only live and grow in a living cell; the causative agent in an infectious disease.
Steam Cleaner	Handheld device used for cleaning wheelchairs and carts.

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Tube Dryer	Used to dry rubber or plastic goods following cleaning, this device draws in air, heats it, and circulates it through the cabinet.
Washer/Sterilizer	Good for cleaning metalware, surgical instruments, and glassware. Uses steam under pressure to render items sterile.
Washer/Sanitizer	Uses steam to thermally sanitize items. Considered less effective than the Washer/Sterilizer.
Ultrasonic Cleaner	Uses sound waves and a process called cavitation to remove soil particles.
Scope Washer	Requires an adapter to force cleaning solution through the channels of flexible scopes.

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Module 3 - DECONTAMINATION

1. TRUE/FALSE DECONTAMINATION IS THE PROCESS OF DECONTAMINATING OR PURGING MEDICAL DEVICES OF FLUID AND OR DEBRIS TO INCREASE THE BIOBURDEN OF THAT INSTRUMENT OR DEVICE.

TRUE - FALSE

2. DECONTAMINATION AREA'S WITHIN SPD MUST MEET ALL OF THE FOLLOWING *EXCEPT?*

A. BE A RESTRICTED AREA PHYSICALLY SEPARATED FROM THE REST OF SPD
B. MUST HAVE LOW LIGHTS TO BE ABLE TO SEE STAINS ON INSTRUMENTS
C. BE UNDER NEGATIVE AIR FLOW PRESSURE
D. DESIGNED WITH SURFACES THAT CAN WITHSTAND DAILY CLEANING

3. UNDER UNIVERSAL PRECAUTIONS/STANDARDS ALL USED EQUIPMENT AND SUPPLIES ARE TO BE?

A. OPENED IN THE PREP AREA
B. WASHED WITH A BLEACH SOLUTION
C. TREATED AS IF THEY ARE CONTAMINATED
D. LEFT FOR THE NEXT SHIFT TO PROCESS

4. PPE USED IN SPD AREAS INCLUDE ALL OF THE FOLLOWING *EXCEPT?*

A. HAIR COVERS
B. IMPERVIOUS GOWNS
C. FACE MASKS, FACE SHIELDS, GOGGLES
D. EXAM GLOVES

5. DETERGENTS AND DISINFECTANTS SHOULD ALWAYS BE?

A. ITS INTENDED PURPOSE
B. USED WHENEVER YOU WANT
C. USED WITHOUT AN MSDS SHEET
D. USED ONLY AT THE BEGINNING OF EACH SHIFT

6. BEFORE USING A NEW SOLUTION OR CHEMICAL INSIDE SPD THE TECHNICIAN SHOULD?

A. MAKE SURE THE BOTTLE HAS A SPRAYER FOR EASY APPLICATION
B. ENSURE IT MIXES WELL WITH WATER
C. READ THE MSDS FOR THAT SPECIFIC PRODUCT
D. MAKE UP A SMALL BATCH TO SEE IF IT HAS A STRONG ODOR.

7. DETERGENTS SHOULD BE SELECTED FOR USE IN SPD BASED ON THEIR?

A. COLOR
B. PH LEVEL
C. SMELL
D. TASTE

8. A SOLUTION WITH A PH LEVEL BELOW 7.0 IS CONSIDERED?

A. ALKALINE
B. ACIDIC
C. SAFE FOR CONSUMPTION
D. NONE OF THE ABOVE

9. DISINFECTANTS ARE CLASSIFIED AS?

A. CLEANERS
B. HIGH, MEDIUM, LOW
C. STRONG, HARSH, GENTLE
D. WEAK, WATERY, PUNGENT

10. TRANSPORTATION OF SOILED OR CONTAMINATED ITEMS FROM AREA'S WITH IN THE FACILITY TO SPD MUST BE IN?

A. SOLID CONTAINERS
B. DEDICATED CARTS
C. DEDICATED LIFTS/DUMBWAITERS
D. ALL OF THE ABOVE

11. TRUE/FALSE CARTS OR LIFTS DESIGNATED CLEAN CAN BE INTERCHANGED WITH ONES THAT ARE DIRTY.

TRUE - FALSE

12. ITEMS INSIDE DECON SHOULD BE SEPARATED BY?

A. WEIGHT
B. SIZE
C BOTH A & B
D. THE PROCESSING METHOD THAT THEY REQUIRE

13. THE PURPOSE OF DECONTAMINATION IS?

A. PROCESS AS MANY ITEMS AS POSSIBLE
B. TO HELP HOUSE KEEPING WITH CLEANING
C. TO REDUCE BIOBURDEN
D. TO BREAK IN THE NEW EMPLOYEE

14. TRUE/FALSE YOU SHOULD NEVER CHANGE OR RINSE OUT THE CLOTHE YOU ARE USING TO CLEAN EQUIPMENT BETWEEN PIECES.

TRUE - FALSE

15. YOU SHOULD CLEAN ALL EQUIPMENT?

A. BOTTOM TO TOP
B. TOP TO BOTTOM
C. DIRTIEST AREA FIRST
D. IN BARE HANDS

16. YOU SHOULD ALWAYS CLEAN YOUR RUBBER OR PLASTIC ITEMS IN?

A. IODINE
B. SONIC CLEANERS
C. PASTEURMATIC WASHER
D. PLAIN TAP WATER

17. WHEN WASHING/SCRUBBING INSTRUMENTS IN DECON YOU SHOULD KEEP THE ITEMS?

A. NEXT TO A POWER SOURCE TO BE ABLE TO SEE IF THEY STILL WORK
B. ABOVE THE LEVEL OF THE WATER TO BE ABLE TO SEE THEM BETTER
C. DRY SO AS NOT TO PROMOTE RUST
D. BELOW THE LEVEL OF THE CLEANING SOLUTION TO HELP AVOID SPLASHING

18. BEFORE PROCESSING ANY RIGID OR FLEXIBLE SCOPE THE TECHNICIAN SHOULD?

A. HOLD IT UP SEE YOU CAN SEE DOWN THE LUMEN
B. READ ALL MANUFACTURES PROCESSING INSTRUCTIONS
C. SUBMERGE THE SCOPE INTO WATER
D. PULL FIBER OPTICS FROM THE END OF THE SCOPE

19. THE PROCESS INSIDE OF A SONIC CLEANER WHERE MICROSCOPIC BUBBLES IMPLODE DISLODGING PARTICLES AND DEBRIS IS CALLED?

A. CLEANING
B. BUBBLE BATH
C. CAVITATION
D. SONICATION

20. BEFORE A SPD TECHNICIAN PUTS A SCOPE INTO AN AUTOMATED SCOPE WASHER HE/SHE SHOULD?

A. BRUSH THE CHANNELS
B. PERFORM A LEAK TEST
C. DO AN ALCOHOL RINSE
D ALL OF THE ABOVE
E. A & B

Section Four: Surgical Instrumentation

Estimated Contact Time:
80-110 minutes

This module covers:

….an overview of surgical instrumentation and its use. It will provide a foundation for the learner to build on as s/he becomes more familiar with specific instrumentation through daily tasking.

Following instruction, you should be able to perform the following:

- ☑ Label basic instruments and identify their use.
- ☑ Demonstrate proper placement of instruments for trays, sets, containers, and stringers.
- ☑ Identify processing, handling, and testing procedures for basic surgical instruments.

The Role of Surgical Instrumentation

As surgical technology continues to advance, so does the type and complexity of surgical instrumentation. Surgical instruments are a major investment for the medical center and they require special care and handling to maintain proper function and longevity.

Surgical instruments are highly specialized, finely crafted medical tools. They include handheld devices such as scalpels, retractors and forceps, endoscopic equipment, and a variety of powered equipment for special applications. Instrumentation may vary from facility to facility, but SPD technicians and operating room staff must be able to recognize, assemble, and use thousands of different types of surgical instruments and devices.

Reusable surgical instruments require careful processing in order to assure a longer life and to prevent the transmission of infection. SPD is responsible for inspecting the instruments prior to sterilization and ensuring that they have been:

- properly cleaned

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- tested
- checked for functionality and damage
- assembled according to an accurate and detailed procedure list.

Damaged instruments must be sent for repair and a replacement placed in the set.

The three common types of equipment are:

- handheld
- endoscopic
- powered

Each type has its own special functions and processing requirements. New technologies are constantly emerging and SPD must be prepared to accept and process new devices on an ongoing basis.

Handheld Instruments

Handheld instruments, which are the most common, can be general use, microsurgical, or laser. They come in a wide assortment of designs, sizes, and applications, and can be categorized by their

- type,
- use,
- composition, and
- processing requirements.

Once you have learned to recognize the type of instrument and what it is used for, it will be easier to distinguish between the many different sizes and varieties. The basic groups or types include the following.

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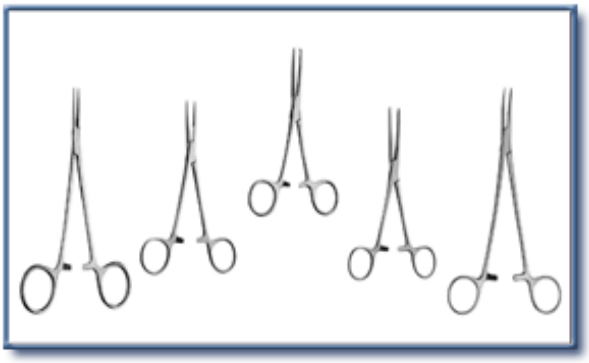
Hemostatic Forceps



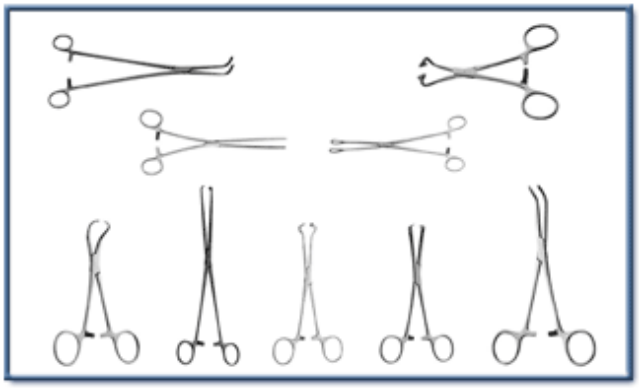
Hemostatic forceps can be called clamps, artery forceps, and hemostats. The main purpose of hemostats is to achieve hemostasis (arrest of bleeding). Most hemostats are available:

- in different lengths
- curved and straight
- with serrated jaws (some also have toothed ends)

There are a number of different kinds:

- Mosquito
- Kelly
- Kocher
- Carmalt
- Tonsil

Soft Tissue Ring Forceps



Soft tissue forceps are used for holding and retracting soft tissue. They have fine teeth or ridges on the jaws to provide a delicate grip without causing trauma to tissue. Like hemostatic forceps, they have ring handles and box locks.

There are a variety of types:

- Backhaus Towel
- Allis Intestinal
- Babcock Intestinal
- Lahey
- Mixter Gall Duct

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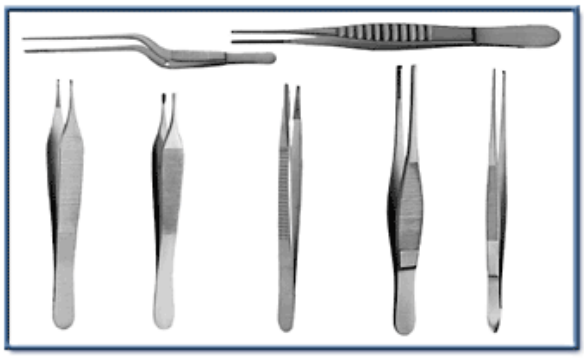
- Doyen Intestinal
- Right Angle
- Sponge
- Non-perforating Towel Clamp

Soft Tissue Thumb Forceps

Thumb forceps do not have box locks or ring handles. They have spring handles which are held closed by thumb and finger pressure.



Sometimes, when the jaws are serrated and the instrument is used to grasp delicate tissue or wound dressing, this type of forceps is called a dressing forceps.

A heavier version of this type of forceps is referred to as thumb tissue forceps. They have teeth that will provide a more secure grasp on heavier tissue.

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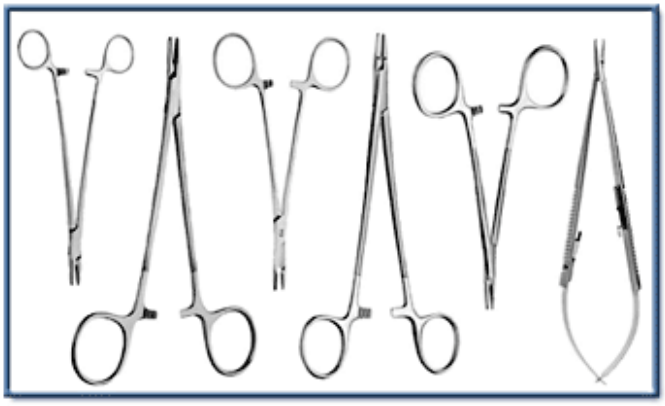
The various types include:

- Adson
- Brown-Adson
- Dressing
- Thumb with Teeth
- Russian
- Cushing
- DeBakey

Needle Holders

Needle holders are used to hold needles, which are attached to sutures. Sometimes referred to as needle drivers, this type of instrument is similar to hemostats but with shorter and thicker jaws. They generally have ring handles.



Needle holders are available in a variety of lengths and styles and may be curved or straight. Some of the varieties include:

- Mayo-Heagar
- Crile-Wood
- Olsen-Hegar
- Collier
- Webster
- Castroviejo

Needle holders have inserts in the jaw to prevent excessive wear. The inserts are usually made from tungsten carbide granules in a cobalt or other metal paste. Needle holders with tungsten carbide inserts are normally identified with gold plated handles. The

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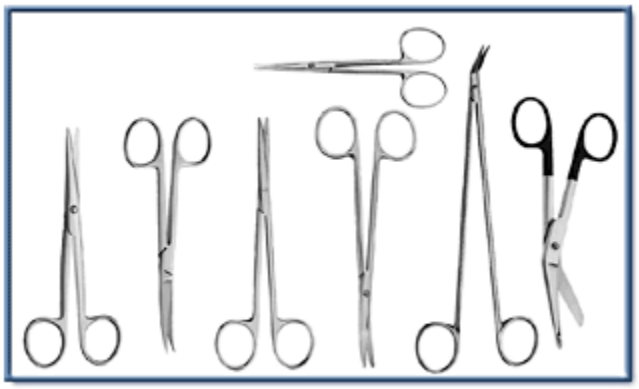
inserts can be replaced as they wear down. This prolongs the life of the needle holder and defrays the cost of replacing the entire instrument.

Needle holders can have spring handles. This allows the user maximum results with minimum rotation of the wrist and hand. Most spring handled needle holders will have a lock or catch to secure the needle. They are used in surgical procedures that require delicate suturing in tight or poorly exposed areas. Spring handled needle holders may also contain replaceable inserts.

Scissors



A variety of scissors are used in the surgical suite.

- Curved scissors are generally used to cut and dissect tissue.
- Straight scissors are generally used for cutting sutures and 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.

Surgical scissors should *never* be used to cut paper or tubing. Bandage scissors may be utilized for this purpose. Scissors used for cutting suture should not be used on tissue because sutures can damage delicate scissors, keeping them from giving a clean cut.

There are a number of different types of scissors in use:

- Mayo Dissecting Straight
- Mayo Dissecting Curved
- Metzenbaum
- Metzenbaum Delicate

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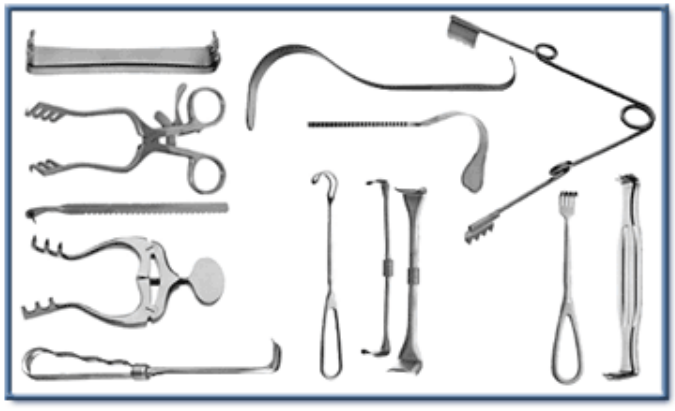
- Lister Bandage
- Iris Straight
- Stevens Tenotomy
- Potts-Smith

Mayo scissors are identified by heavy curved or straight blades with rounded tips. Straight mayo scissors are often used for cutting suture. Metzenbaum (Metz) scissors, are similar to Mayo, only lighter in pattern and more delicate. Iris (dissecting) scissors resemble cuticle scissors but are 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 can be identified by their serrated, angular blades with a groove for holding the wire as it is being cut.

Scissors can 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.

Retractors



Retractors are used for holding the incision open to provide exposure to the surgical site. Many varieties and sizes of retractors are available, and the use of specific retractors will depend on the type of surgical procedure being performed.

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. Self-retaining retractors are held open by

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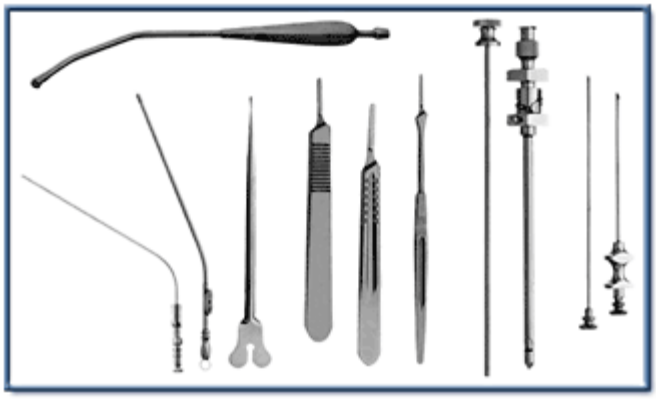
their own action and require no assistant to hold them. They may be used in conjunction with the hand-held retractors. Varieties include:

- Richardson-Eastman
- Richardson-Kelly
- Mayo
- Jansen Mastoid
- Weitlander
- Gelpi
- Spring Wire
- Volkman Rake
- Green Goiter
- Army-Navy
- Deaver
- Sweetheart

Miscellaneous



Probes, biopsy needles, and suction tubes are a few of the miscellaneous instruments required for use in surgery and 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.

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Examples of probes and knife handles are:

- probe with eye,
- optical probes, and
- knife handles number 7, 4, and 3.

Biopsy needles are used to remove 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 tissue damage.

Suction tubes are used to remove blood, tissue, and fluids from the surgical site to allow surgeons a clear view of the anatomical structures during the operative procedure. The tube is attached to suction tubing connected to a graduated reservoir to measure the amount of fluid removed. Several types of tubes may be used, depending on the procedure. Many will have removable tips that require close attention during the cleaning process.

Composition of Handheld Surgical Instrumentation

Surgical instruments are finely crafted tools, fabricated to resist corrosion and to deliver high-quality performance through multiple uses. This section examines the structure, composition and grades of surgical instruments.

Components

The structure of a typical handheld hemostat or clamp consists of jaws, box lock, shanks, ratchets, and finger rings. Surgical scissors consist of jaws, shanks, finger rings, and a screw.

The box lock on clamps employs a rivet, and is the weakest part of the instrument. The box lock needs to be carefully examined for fractures after each use.

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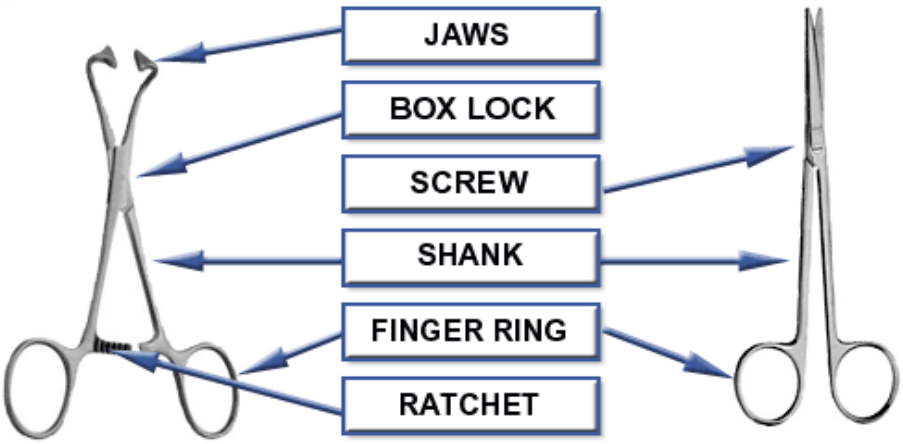

Surgical scissors—like ordinary scissors—employ a screw mechanism to allow cutting action. If the scissors are loose they must be sent for professional repair.

Never tighten the screw, it will strip and render the scissors useless.

Composition

Stainless steel is an ideal material for surgical instruments because it:

- resists rust and nicks
- maintains a fine point
- retains a keen edge for cutting

Stainless steel varies in grade. Despite its name, stainless steel can spot and stain. In actuality, there is no truly "stainless" type of steel.

Many surgical instrument companies use a technique called "passivation" to assure the least amount of staining and spotting. Passivation occurs by exposing an instrument to the atmosphere or certain other oxidizing agents which results in a thin, protective surface or film. Repeated processing increases resistance to corrosion by further passivating the surface, which explains why older instruments tend to stain and spot less than new ones.

Other metals used in the construction of surgical instruments are:

- Titanium Alloy
- Copper

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- Brass

There are four basic types of instrument finishes. Each finish has its own characteristics and applications.

- **Mirror**—A shiny or mirror finish does not spot and discolor as easily as other finishes. Mirror finishes tend to reflect light and can restrict the surgeon's vision of surgical site.
- **Satin**—A satin finish, also called a "patina", reduces the glare at the wound site, but tends to stain and spot more frequently.
- **Matte**—A matte or dull finish, like a satin finish, reduces the glare at the wound site but tends to stain and spot more frequently. A matte finish is attained by a sandblasting technique using glass beads or silicone.
- **Ebonized**—An ebonized finish is a black, microscopically irregular surface which scatters and absorbs laser energy. It is created by placing the instruments in a chemical bath. During laser surgery, this non-glare finish keeps energy from bouncing onto healthy tissue surrounding the intended target.

Electroplating

Electroplated instruments have a highly polished finish that is often easier to keep shiny. The electroplating process can leave holes in the finish, resulting in potential rust and deterioration.

Once electroplating starts to deteriorate, the instrument should no longer be used because it cannot be sterilized and there is a possibility that the plating will chip into the surgical site and cause infection.

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Grades

There are two grades of surgical instruments.

Floor Grade	• Made from forgings of lower grade quality metals—usually plated • Bend or break easily, and are more subject to chipping and rust • Less precise than the higher quality O.R. grade instruments • Once plating is chipped, instrument cannot be sterilized
O.R. Grade	• Made from 300-4 grade stainless surgical steel • More resistant to corrosion and wear • Must be processed separately from the Floor Grade instruments, since rust can spread if these instruments are mixed

Cleaning and Decontamination

Surgical instruments represent a significant expense for the medical center. Their proper handling can help control costs by extending the useful life of these precision tools. 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. 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 include:

- Mercury bichloride
- Phenol
- Mercury salts
- Potassium thiocyanate
- Ferrous chloride

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- Hydrochloric acid
- Iodine
- Aluminum chloride
- Barium chloride
- Calcium chloride
- Blood
- Carbolic acid
- Chlorinated lime
- Dakin's solution

After surgery, all instruments must be treated as if they were contaminated. They should be placed in covered containers in the *case cart* for transportation to SPD.

DO NOT bounce or drop instruments, or place large, heavy instruments on top of delicate ones.

DO count instruments carefully. Accurate counts are vital for patient care, and for preventing loss by accidentally discarding them or mixing them with surgical linens.

Reprocessing of surgical instruments involves several steps, starting with safe transport to the decontamination area and including cleaning, safe handling and decontamination.

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. All instruments set up in the operating room will require reprocessing, regardless of whether they were used during surgery.

Instruments should be handled to avoid damage and to prevent injury to the technician. Heavy rubber or plastic gloves should be worn, as well as the required decontamination apparel. Handle instruments in small groups to avoid tangling and damage. Separate needles and process them separately. Scalpel blades still

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attached to knife handles should be removed and disposed of in sharps containers.

Many instruments contain sharp edges and parts, and require extreme care when handling.

Cleaning

Inspect 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. Brushes are available in many sizes. There are brushes specially designed for cleaning cannulated areas.

Open all instruments for cleaning. Instruments with box locks should not be in the locked position. Multi-piece retractors, staplers, etc., should be disassembled prior to cleaning. This allows for all areas to be exposed to the cleaning process.

Use only non-abrasive cleansers for instrument cleaning. Abrasive cleaners can damage the surface of the instrument, resulting in corrosion and rust. Detergents that are used should maintain a pH between 6 and 8 since a pH level too high (alkaline) or too low (acidic) will damage the surface.

Decontamination

After gross soil has been removed by washing, place the instruments in the ultrasonic. If the gross soil has been removed properly, the ultrasonic will remove the remaining soil, penetrating into the box locks, joints, and screw areas. After instruments are removed from the ultrasonic, visually inspect them for cleanliness, then rinse and place them in the washer/sterilizer.

Preparation and Sterilization

Once instruments have been decontaminated, they are inspected, assembled and packaged for sterilization. You must examine them to make sure they are working properly, and are not bent, broken, or missing parts. Once inspected, they can be assembled and packaged for sterilization.

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The preparation and sterilization process is accomplished in six steps which are summarized below and thoroughly detailed in Module 5, Packaging, and Module 6, Sterilization.

Inspection

Once the instruments have been received into the preparation area, they must be thoroughly inspected for cleanliness and proper function. Any instrument with visible evidence of soil should be returned to decontamination for reprocessing. Check for nicks, rust, corrosion, burrs, pitting, and cracks in the box lock.

Certain instruments should be checked for proper jaw alignment, proper tension, freely moving box locks, loose screws, and freely moving hinges on scissors or other multi-jointed instruments. Test instruments with box locks and ratchets to assure proper function. Test by locking the ratchet into the notch and gently tapping it against the palm of your hand or a counter edge. If the ratchet disengages or pops open, the instrument requires repair. The tips of instruments with jaws should just meet before the ratchet is engaged.

To check a needle holder, place a piece of suture (2-0 silk) in the tip and close it to the first ratchet. Lift the suture, the needle holder should remain securely attached. When visible wear, such as a gap is noticed between the tungsten carbide inserts, they should be replaced.

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. (This is for scissors 4 ½" or longer.) Paper should never be used to test scissors. There are also new products, which resemble the texture of tissue, available for testing the cutting edge of scissors.

Repair or Replacement

It is critical that malfunctioning instruments be pulled for repair rather than being returned to an instrument set. An improperly functioning instrument could cause delays or harm to the patient during the course of the surgery. SPD should:

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- Establish a detailed instrument repair program
- Set aside a designated area for damaged instrumentation
- Contract with a reliable company to ensure correct and timely repairs
- Carefully track the cost of instrument repair

Set or Tray Assembly

Basic sets have the tendency to expand over time to the point that there may be a large number of instruments included that are not being used. Periodic review of basic instrument sets should be done routinely, with input from the surgeons, nursing staff, and SPD supervisor. The set should be maintained so that it is functional yet not overloaded with unused instruments. Excessive instruments increase the weight of the set, and require excessive cleaning and assembly time.

The recommended weight for an instrument set is 16 to 17 pounds, but the size of the tray will determine how many instruments can be placed on it and safely sterilized. Instruments should not be overcrowded into a tray that is too small. This will prevent the proper exposure to the sterilizing agent. If the set becomes too large and the staff requires all the instruments, the set can be broken down into a regular basic set and a smaller, supplemental set. Placement and tray size are as vital, if not more important, than weight.

Color coding of instruments, using instrument tape, is not recommended.

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

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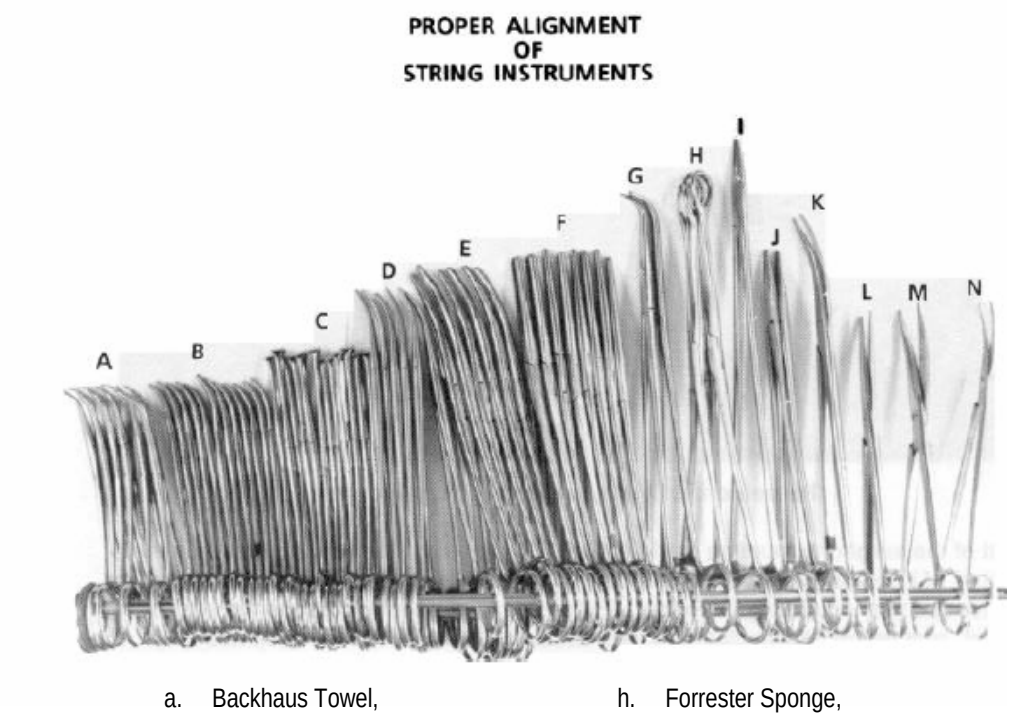
heavy items, such as retractors, should be placed on the bottom of the tray. The stringed instruments should go in last and be placed on the stringer or rack in a manner that prevents damage to the instruments and allows easy, orderly access by the operating room scrub nurse.



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

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.

Many facilities use towels or absorbent disposable tray liners to prevent instruments from protruding through tray perforations. 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.

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Preparation

Once a set is assembled, items to be sterilized are packaged using a set of assembly guides or count sheets. The technician who prepares the tray should initial the content inventory. A quality assurance program must be implemented to ensure that instrument sets are complete. Each item assembled and sterilized must be marked with the name of the set or item and the initials of the technician who packaged them.

The set is *sequentially double wrapped* with muslin or non-woven disposable wrap, or placed into a container system, and placed flat on the sterilization rack. Never tip a surgical instrument set on its side. Tipping will cause displacement of the instruments and may damage them.

Individual instruments can be packaged in peel packs (paper/plastic pouches). 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 may be required for items used in surgery. Sequential double wrapping in muslin or non-woven disposable wrap accomplishes the same effect.

Sterilization

The sterilizer cart or rack must be loaded to allow for free circulation of the sterilizing steam or gas. Leave at least enough space to place an open hand between items. Linen items should be on the top shelf and trays and metal items on the bottom. This prevents condensation from the metal items from dripping on the linen packs. Condensation can cause staining.

Staining and spotting may be an indication of contamination. Several conditions can cause it. Steam may contain minerals and rust deposits from the steam line (steam line filters can be installed to help prevent this). Residual soap from improperly rinsed linen can redeposit on instruments during sterilization. For this reason, it is recommended that surgical linen packs be processed alone. Other causes of staining and spotting are listed in the following chart.

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Stain	Cause
Rust colored	• Mineral deposits from tap water in the final rinse • Detergent residues from improperly rinsed laundry • Incorrect pH detergent used in the washer/sterilizer • Combining imperfect chrome instrument with stainless steel instruments
Bluish gray	• Cold sterilizing solutions inadequately rinsed from instruments
Purple black	• 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 compounds • Detergent residue or high pH • Metals with dissimilar composition processed together

Storage & Transport

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 strikethrough. Wrapped sets must be entirely cool prior to dust covering and handling. Due to moisture present in the packaging, the sterility of wrapped sets that are handled prior to cooling may be compromised.

A sterile storage area must be provided for all sterilized sets kept in SPD. The sets should be placed on the shelves so that dust covers and wraps remain intact. Containerized systems may be stacked. Instrument sets should never be tipped sideways during storage. If instrument sets must be stored in the operating room, they should be transported in clean, impervious covered, or contained carts and handled with care and good judgment during transportation.

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Endoscopic Equipment

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. Endoscopic instruments are complex and may consist of several lenses carefully aligned along the instrument, one or more lumens, and may contain fiber optic bundles. All endoscopic equipment requires extreme care during use and cleaning. Detailed procedures and information for sterilization are required to prevent unnecessary damage. Inservice training should be provided for each specific instrument to assure that technicians possess the skill and knowledge required to process the equipment safely and effectively.

Rigid endoscopes

Includes gastroscope, cystoscopes, resectoscopes, laparoscopes, and arthroscopes

Always follow the manufacturer's recommendations concerning proper cleaning and sterilization procedures for rigid endoscopes. They 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. Close attention is required when cleaning these items. Air and water pistols must be used to dislodge debris from recessed areas and protective attire is required to prevent exposure to aerosols that might be produced. A neutral pH detergent should be used to prevent damage to sensitive equipment parts.

Some rigid endoscopes, such as a Jako Laryngoscope, do not contain lenses and may be processed through the washer/sterilizer. 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 (for example, a Berry rotating sheath used for cystoscopys) will not tolerate the ultrasonic due to the type of epoxy used to manufacture the sheath.

Preventive care should include the following:

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- Do not autoclave telescopes or resectoscopes (unless they are specifically designed to be autoclaved).
- Never bend, drop, or pile instruments on top of telescopes.
- Do not use ultrasonic cleaning which tends to loosen optical cement from the lens.
- Routinely lubricate stopcocks or moving parts with silicone lubricant.
- Use only nonabrasive metal polish on metal parts only.
- Be very careful while cleaning the lens on rigid telescopes. Alcohol, if used repeatedly, may cause the glass to appear scratched.

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, which has allowed moisture to enter, somewhere on the telescope. The shaft of the telescope and the light cord contain bundles of glass rods that conduct light to allow examination 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. The light carriers or cords are manufactured to withstand steam sterilization but care must be taken not to bend the cords or light carriers so that the glass bundles are damaged.

Always check the light carriers by holding one end to the light while looking 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 must be repaired or replaced.

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. 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

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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.

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.

Flexible scopes

Includes esophogusgastroduodenum (EGD) scopes, bronchoscopes, sigmoidoscopes, and colonoscopes

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. 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.

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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. Immediately following the procedure, these ports and channels should be flushed, brushed, and rinsed to prevent any debris from drying. The flexible scope can 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.

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.

The procedures that a scope is used for, along with input from infection control, will normally determine the type of processing and the level of disinfection or sterilization required. Regardless of the point of use, all reprocessing should be accomplished within SPD. 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.

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Powered Equipment

Powered equipment used in surgery includes a wide variety of equipment and several different power sources. Power sources may be electrical, either line current or battery, or compressed medical gasses, such as carbon dioxide, nitrogen, or compressed air. Equipment powered by gasses is 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.

Powered equipment should be cleaned and cared for according to the manufacturer's recommendations.

In general, power instruments should not be immersed in a solution of any kind. They should never be processed through an ultrasonic cleaner or washer/sterilizer.

Processing

Close attention should be given to ensure the powered equipment and attachments are thoroughly inspected and cleaned. Attachments used with powered equipment, may be processed in the same manner as most stainless steel surgical instruments. Attachments include:

- chucks
- chuck keys
- burr guards
- hudson and trinkle adapters
- wrenches

All attachments must be removed from the equipment before processing.

- Skull perforators should be checked frequently and sent for sharpening on a routine basis.
- Air hoses should be inspected for any damage prior to cleaning, then washed with a mild detergent and lukewarm water.

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- If the equipment has an electrical cord, the cord may be washed with a cloth soaked with mild detergent solution. Never immerse the cord in any solution.
- Sterilization by a pre-vacuum steam sterilizer is recommended for most equipment.
- Electrical equipment should be sterilized by ethylene oxide to prevent damage to the electrical parts.

Lubrication

Older equipment requires some lubrication, and this should be done during the testing process. Newer powered equipment requires no lubrication since it is self-lubricating, within a sealed casing. Pneumatic equipment should be hooked up to compressed air and tested within the required pounds per square inch (PSI).

New Technology

As surgical procedures and techniques change, so do the types of surgical instrumentation and implants, making it difficult for medical centers to keep pace with the instrumentation required to perform newer procedures (for example, orthopedic implants are being developed and improved upon so fast that equipment is outdated almost as soon as it is used). To alleviate this problem, many companies loan the necessary instrumentation to the medical centers. It is more cost-efficient for both parties.

Loaner instrumentation must be brought directly to the decontamination area of 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. The instrument set is then 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, the set is placed on the case cart. If the medical center does not utilize a case cart system, the instrument set should be hand delivered to the operating room. After surgery, the loaner instrument sets must be returned to decontamination, processed, and reassembled (?but not sterilized?). Prior to leaving the medical center, the SPD supervisor or

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technician should again check the set against the list to ensure 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.

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.

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, and must ensure that all items leaving the medical center have been thoroughly cleaned to prevent any cross contamination.
Before processing any new technology, the technician should consult all manufacturers' instructions.

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Summary

Surgical instruments, flexible and rigid scopes, and powered equipment come in many varieties and 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. 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.

In this module you have learned:

- The names and function of basic instruments (what they are called, how they are used)
- The proper placement of instruments for trays, sets, containers, and stringers.
- The processing, handling, and testing procedures required for basic surgical instruments—including handheld, endoscopic, power, and new technology.

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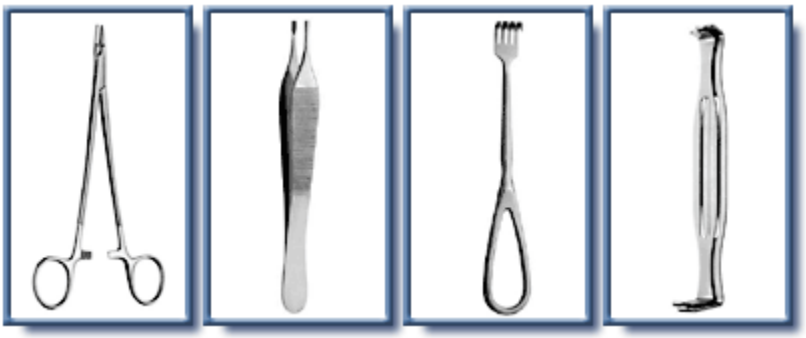
✓ Check What You Know

Answer these questions to gauge your understanding of the material covered in this module.

1. What type of instrument is this?



A B C D

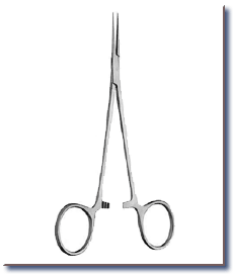
A. _____

B. _____

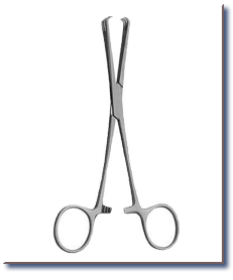
C. _____

D. _____

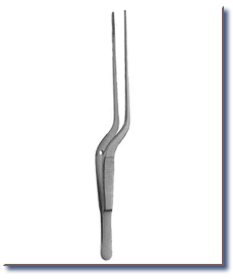
2. Draw a line from each picture to its name.



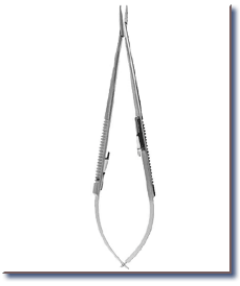
Needle Holders – Castroviejo



Hemostatic forceps – Mosquito



Soft Tissue Ring forceps – Lahey



Soft tissue Thumb Forceps – Dressing

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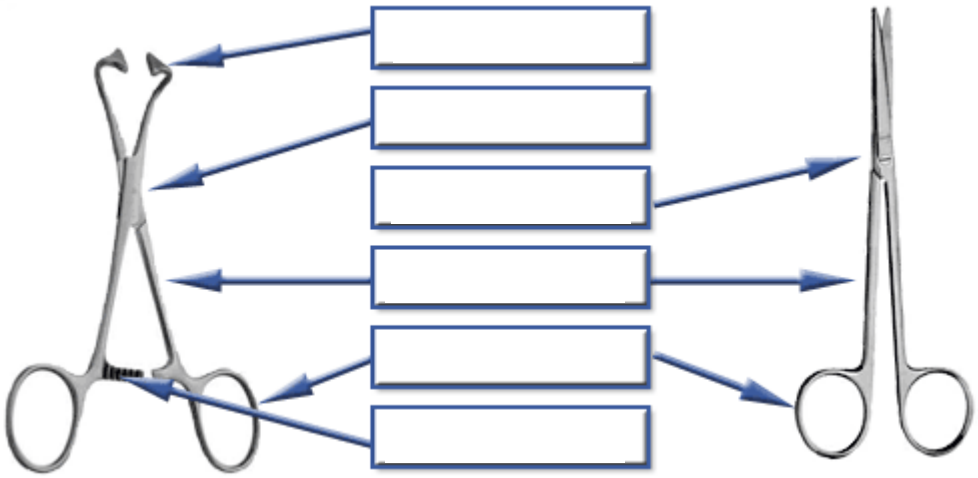
3. Label each instrument component.



4. The advantage of a mirror finish is: _____.
   a. It does not spot or discolor easily
   b. It is easier to clean than a matte finish
   c. Mirror finishes are less expensive to produce
   d. Mirror finish helps illuminate the work area

5. An ebonized finish is a non-glare surface primarily used for _____ :
   a. Microsurgery
   b. Neurosurgery
   c. Laser Surgery
   d. General Surgery

6. What is the recommended pH level of detergent for cleaning handheld instruments?

   _____

7. What should you do when inspecting a soft tissue forceps?

   _____

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_____

8. How do you test a needle holder?

_____

_____

_____

_____

9. When arranging an instrument set to be wrapped and sterilized, what is the proper order?

_____

_____

10. Which of the following are flexible endoscopes? Circle them.

Gastrointestinal scopes	Colonoscopes	Laparascope
Hysteroscope	Resectoscopes	Sigmoidoscopes
Arthroscopes		

11. Which of the above are rigid endoscopes? Underline them.

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Terminology

The following terms were used in this module.

cannulated	having a small tube designed to be inserted into a body cavity, duct, or vessel
case cart	a mobile unit equipped with supplies and equipment that are specific to a certain procedure or "case"
gross soil	excessive blood or body tissue that would impair the use of a surgical instrument.
lumen	a long hollow cavity
passivation	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 corrosion, spotting, and staining
terminally sterilized	sterile and ready for use on a patient

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Module 4 - SURGICAL INSTRUMENTATION

1. TRUE/FALSE SURGICAL INSTRUMENTS ARE HIGHLY SPECIALIZED MEDICAL TOOLS THAT CAN INCLUDE SCALPELS, RETRACTORS, FORCEPS, ENDOSCOPY EQUIPMENT, AND A VARIETY OF POWERED ITEMS.

TRUE - FALSE

2. HAND HELD INSTRUMENTS ARE CATEGORIZED BY THEIR?

A. SIZE, TYPE, USE, COMPOSITION
B. WEIGHT, USE, TYPE, PROCESSING REQUIREMENTS
C. TYPE, USE, COMPOSITION, PROCESSING REQUIREMENTS
D. THE COLOR OF THE INSTRUMENT

3. WHICH OF THE FOLLOWING ARE TYPES OF HEMOSTATIC FORCEPS?

A. MOSQUITO, RIGHT ANGLE, KELLY, KOCHER, CARMALT, TONSIL
B. MOSQUITO, ADSON, KELLY, KOCHAR CARMALT, TONSIL
C. MOSQUITO, KELLY, KOCHAR, CARMALT, TONSIL
D. NONE OF THE ABOVE

4. TRUE/FALSE SOFT TISSUE RING FORCEPS ARE USED TO ARREST BLEEDING.

TRUE - FALSE

5. SOFT TISSUE THUMB FORCEPS ARE?

A. HELD CLOSED BY A LOCK BOX
B. HAVE RINGS HANDLES WHICH THEM CLOSED
C. HAVE SPRING HANDLES WHICH ARE HELD CLOSED.
D. NONE OF THE ABOVE

6. SPD IS RESPONSIBLE FOR WHICH OF THE FOLLOWING?

A. CLEANING, TESTING, SHARPENING, CHECKING FOR DAMAGE, ASSEMBLING, PACKAGING, STERILIZATION OF ALL REUSABLE ITEMS.
B. CLEANING, TESTING, CHECKING FOR DAMAGE, ASSEMBLING, PACKAGING, PROCESSING
C. TESTING, CHECKING FOR DAMAGE, ASSEMBLING, PACKAGING AND PROCESSING
D. SPD ISN'T SUPPOSED TO WORRY ABOUT INSTRUMENTS

7. SCISSORS WITH TUNGSTEN CARBIDE INSERTS ARE IDENTIFIED BY WHAT?

A. BLUE HANDLES
B. GOLD HANDLES
C. RED HANDLES
D. THERE IS NO DIFFERENCE BETWEEN THESE AND ANY OTHER SCISSORS

8. THE STRUCTURE OF A TYPICAL HAND HELD HEMOSTAT CONSISTS OF?

A. JAWS, BOX LOCK, SHANKS, RATCHETS, FINGER RINGS
B. JAWS, BOX LOCK SCREW FINGER RINGS, SHANKS
C. JAWS, SHANKS, RATCHETS, RETRACTORS, FINGER RINGS
D. NONE OF THE ABOVE

9. WHAT ARE THE FOUR BASIC FINISHES FOR INSTRUMENTS?

A. MIRROR, ELECTROPLATING, SATIN MATTE, EBONIZED
B. MIRROR, SATIN, MATTE, EMBONIZED
C. COPPER, SATIN, MATTE, EBONIZED
D. ALL OF THE ABOVE

10. THE WEAKEST PART OF AN INSTRUMENT IS?

A. JAWS
B. LOCK BOX
C. FINGER RINGS
D. SHANK

11. WHEN ASSEMBLING INSTRUMENT TRAYS, RING HANDLED INSTRUMENTS SHOULD BE?

A. PLACED IN THE BOTTOM OF THE TRY

B. IT DOES NOT MATTER AS LONG AS ALL THE INSTRUMENTS ARE IN THE TRY
C. PLACED ON A STRINGER TO KEEP INSTRUMENTS IN AN OPEN POSITION
D. CLOSED

12. INSTRUMENTS WITH MULTIPLE PARTS SUCH AS A BALFOUR RETRACTORS SHOULD BE?

A. KEPT TOGETHER TO HELP THE OR STAFF FIND ALL THE PARTS
B. PLACED IN DIFFERENT PACKAGES
C. INSTRUMENTS SHOULD BE DISASSEMBLED TO ASSURE STERILANT REACHES ALL SURFACES.
D. IT DEPENDS ON WHICH DOCTOR IS GOING TO BE DOING THE SURGERY

13. WHEN LOADING STERILIZATION CART WHICH OF THE FOLLOWING RULES APPLIES?

A. LINENS ON TOP
B. HEAVY ITEMS ON THE BOTTOM SHELF
C. BIOLOGICAL IN CENTER OF LOAD
D. ALL OF THE ABOVE

14. INSTRUMENT STAINING AND SPOTTING CAN OCCUR WITH?

A. IMPURITIES IN THE STEAM
B. COMBINING DIFFERENT GRADES OF INSTRUMENT TOGETHER
C. DRIED BLOOD LEFT ON INSTRUMENT
D. ALL OF THE ABOVE

15. DATING OF THE SETS IS DONE WHEN??

A. AFTER STERILIZATION AND AFTER COOL DOWN PERIOD.
B. BEFORE LOADING STERILIZER
C. WHEN YOU HAVE THE TIME
D. AFTER BIOLOGICAL COMES BACK NEGATIVE

16. ENDOSCOPES ARE VERY DELICATE, WHICH OF THE FOLLOWING STEPS SHOULD BE TAKEN WHEN HANDLING THEM?

A. THEY SHOULD BE AUTOCLAVED
B. NEVER BEND, DROP OR STACK SCOPES
C. REFRAIN FROM USING ALCOHOL ON LENSES THIS CAUSES SCRATCHING
D. B & C

17. TRUE/FALSE TO CHECK THE LIGHT SOURCE OF AN ENDOSCOPE YOU SHOULD HOLD ONE END TO THE LIGHT WHILE LOOKING THROUGH THE OTHER.

TRUE - FALSE

18. TYPES OF POWER SOURCES FOR POWER EQUIPMENT ARE?

A. NITROGEN
B. GASOLINE.
C. BATTERY
D. A & C
E. ALL OF THE ABOVE.

19. WHEN RECEIVING "LONER INSTRUMENTS" FROM A VENDOR THE INSTRUMENTS MUST BE?

A. TREATED THE SAME AS ANY OTHER TRAY RECEIVED FOR PROCESSING
B. STERILIZED IMMEDIATELY AFTER RECEIPT
C. FLASHED STERILIZED AND SENT INTO THE OR
D. TAKEN TO CONTAIN THE NUMBER OF INSTRUMENTS JUST LIKE THE VENDOR SAID.

20. WHICH OF THE FOLLOWING ARE EXAMPLES OF FLEXIBLE ENDOSCOPES?

A. COLONOSCOPE
B. SIGMOLDOSCOPE
C. ARTHROSOPES
D. ALL OF THE ABOVE

Section Five: Packaging

Estimated Contact Time:
45-65 minutes

This module covers:

…how to properly pack and wrap materials for sterilization and storage. Proper packing is important to protect supplies and equipment during processing, and to retain sterility until the items are needed for use.

Following instruction, you should be able to perform the following:

- ☑ Identify packaging materials, methods, and procedures.
- ☑ State packaging requirements.
- ☑ Properly assemble materials for packaging.
- ☑ Demonstrate appropriate wrapping techniques and identify sterile handling and storage requirements.

"Big Things Come In Small Packages"

The main purpose of the packaging process is to protect supplies and equipment during processing and storage so that they remain sterile until they are used on a patient. All of the effort that goes into cleaning, disinfecting, and sterilizing a medical device is wasted if the packaging method and material are not sufficient to prevent microorganisms from returning to the device surfaces.

Basic Packaging Requirements

Although packaging materials may vary from medical center to medical center, and the packaging method is often dictated by the type of equipment you are packaging, there are some basic principles that govern all packaging;

- **Breathable**—Packaging must be breathable to allow the sterilant to penetrate to all device surfaces. It must also allow air, steam, or ethylene oxide to escape during the sterilization process.

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- **Maintain sterility**—The package exists to preserve sterility. The packaging material must keep out microorganisms and since they thrive in moisture, it should be moisture resistant with tamper proof seals.
- **Tolerate handling**—Before an item can be used for patient care it must be removed from the sterilizer, stored, and transported to where it is needed. The packaging must withstand repeated handling, resisting punctures and tears, while protecting the package contents. If the packaging does become damaged or torn, it should be easy to see so that the item can be removed from use and reprocessed rather than accidentally being used. Fragile items should be processed in rigid plastic and metal containers to protect them from being crushed or broken.
- **Withstand sterilization**—Vacuum and pressures created during sterilization are extreme. Changes in temperature can cause melting, burning, or warping. The packaging material must be able to stand up to the pressure without bursting, deteriorating, or coming unsealed.
- **Facilitate aseptic delivery**—The best wrap in the world is no good unless the user can access the item when it is needed, without contaminating it. Wraps that make it difficult to remove the product can hinder the quality of patient care. It is helpful if the packaging allows you to tell what is inside without opening it.
- **Good, fast, and cheap**—Because of the volume of use, packaging materials should be inexpensive, readily available, and easy to use. The easier a material is to use, the more likely it is that packages will be wrapped correctly.

Types of Packaging

There are a number of packaging options. The packaging method and type of material that you use will be determined by:

- the type of item to be packaged
- the item's size and use
- the sterilization method to be used

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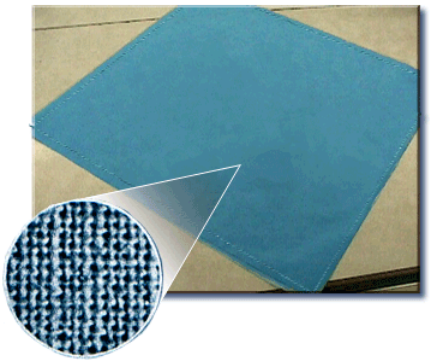
Too much packaging can inhibit sterilization, while too little will not provide adequate protection.

Textiles



Textiles consist of two layers of fabric sewn together along the edges to create a single wrapper. They come in different types or weights that are distinguished by their thread count—the number of threads woven in a square inch of fabric.

- Muslin is the least efficient with a thread count of 140 or less. It is lightweight and cheap.
- Percale, with a thread count of 140 to 180, is a medium grade fabric that is very common and readily available. Percale is the type of fabric that many bed sheets are made from.
- Pima cotton, with its high thread count of 288, provides an excellent bacterial barrier but is more expensive. It is often treated with quarpel to make it moisture resistant.

Woven textiles require laundering, inspection, delinting, and folding between uses. Because they can be reused, woven wraps may seem cheaper than disposable ones, but the laundering costs and man-hours required to maintain them, make them more costly in the long run. Textile manufacturers recommend that wraps only be laundered 50 to 60 times before being replaced. The number of uses is difficult to track and may result in use of a wrap that has lost most of its barrier capability.

In some medical centers textile wraps are cleaned and serviced by the Laundry, in others SPD is responsible. A light table is required to inspect for holes or damage to woven wraps. Repairs require placing a patch on both sides of the wrap. Patches do not allow penetration of the sterilant and may inhibit sterilization, so large or multiple patches are discouraged.

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Non-woven Materials

Non-woven materials come in a variety of types and thicknesses. They are disposable—intended for a single use—and must be discarded afterwards. Disposables can accumulate in landfills, creating environmental concerns. Several manufacturers of disposables have recycling programs. A recycling program must be carefully planned and thoroughly reviewed to prevent any possibility of cross contamination.

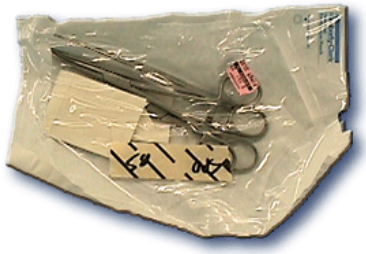
Non-woven packaging materials consist of

- plastic polymers,
- cellulose fibers, or
- pressure-bonded sheets of washed paper pulp.

Plastic polymers are impervious to moisture, but untreated, washed paper pulp can become wet, causing strike through.

Plastic Peel Pouches

Water and water vapor cannot penetrate plastic peel pouches, so they cannot be used for steam sterilization unless they are partially paper. Peel pouches (except for those made from polyvinyl chloride—PVC) may be used for ethylene oxide sterilization. Ethylene oxide does not penetrate well through PVC and the material retains the ethylene oxide after processing.



Plastic films can also be used as dust covers for woven and non-woven wrapped sterile items. A dust cover will protect a properly wrapped, sterilized item from moisture and dust, and extend the shelf life to 1 year. To prevent condensation inside the cover, the item must be completely cool before placing it in the dust cover

Container Systems

Use of container systems is a fairly recent development in the U.S., although they have been used successfully in Europe for decades.

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They were developed to meet the need for greater protection of instruments, as they became more complex and more expensive.

Container systems have a metal or plastic outer case, an inner basket constructed of stainless steel, and a gasket along the lid to assure an airtight seal. A filter, consisting of filter paper and a screen or retainer frame to hold it in place, is built into the container lid or bottom. The lid can be removed aseptically to allow for easy access to the inner basket.

Packaging instruments in containers requires less time than wrapping them in traditional linen wraps. After surgery, soiled items can be placed back into the system for safe transportation to the decontamination area.

Tamper proof indicators must be used with all types of containers. Labels, on the end of the containers, identify the name of the set and the sterilization date. Sterilization indicators can be part of the tamper proof label or may be included on the tag used for the sterilization date and technician's initials.

Each time the container is used the gasket and retainer frames must be inspected for damage or wear. If the container uses a valve, it should also be checked to make sure that it is functioning and won't inhibit the sterilization process.

Sterilizer drying times may require adjustment for container loads because metal does not have the ability to absorb moisture like textile wraps do. In mixed loads of both textile wraps and containers, always place containers on the bottom of the sterilizer to avoid condensation forming and dripping down on the textile packages. Don't stack containers on top of each other during the sterilization process, but they may be stacked for storage.

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Assembling Items for Packaging

How you stack and layer items is just as important as how you wrap them. You want to package each item as efficiently as possible, taking up the minimum amount of necessary room while ensuring maximum penetration of the sterilant.

Linen Pack Construction

Linen packs come in a variety of sizes and are used mainly in the operating room. Towels and other small packs may be used in clinic or special procedure areas. Linen items must be packaged so that they are easy to remove from the package. Fold gowns inside out so that they can be put on without touching the outside. Fold drape sheets so that they are easy to open and place around the operating site.

Linen packs must conform to the following specifications:

- Density not to exceed 7.2 pounds per cubic foot
- Size not to exceed 12 x 12 x 20 inches
- Arranged in the order in which the items will be used
- Arranged to minimize handling and ensure aseptic presentation at the point of use
- Alternating folds to aid in the air evacuation and steam penetration

At most medical centers, the Laundry Department is responsible for all surgical linen. This includes maintenance and care, and folding and assembly of the surgical linen packs. If laundry service is not available, SPD must fold and de-lint linen in a room that is separate from the preparation room.

Procedure Trays

Procedure trays will be assembled using towels, instruments, small basins, med cups, and gauze. Cards or lists will be supplied listing the required items for each procedure. Wrap the required materials in

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muslin or non-woven material and place them on their side during the sterilization process to prevent moisture pooling. Slow moving procedure trays must be placed in dust covers after being processed.

Basin Sets

Basin sets should be constructed so the smaller basins nest inside the larger ones. They should all face the same direction, with a piece of absorbent material 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 sterilant contact to all surfaces.
Metal ware and linen should not be combined in large packs, since the metal may prevent sterilant penetration of all the linen and prevent proper drying.

Instrument Sets

To allow for safe handling and to ensure adequate exposure to the sterilant, instruments should be processed in a tray. The tray may be packaged in muslin or non-woven wraps, or in a containerized system. Construction of instrument sets will be covered in detail in the Surgical Instrumentation module.

Fragile/Delicate Items

Fragile items or those with small components should be processed in container systems, which provide more protection than other types of packaging. Some container systems come with dividers or inserts so that components can be separated and won't knock against each other during processing.

Wrapping Items

Textile Wraps

Once an item, pack, or instrument set is prepared, the proper size wrap must be selected. Choose a 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 should be just tight

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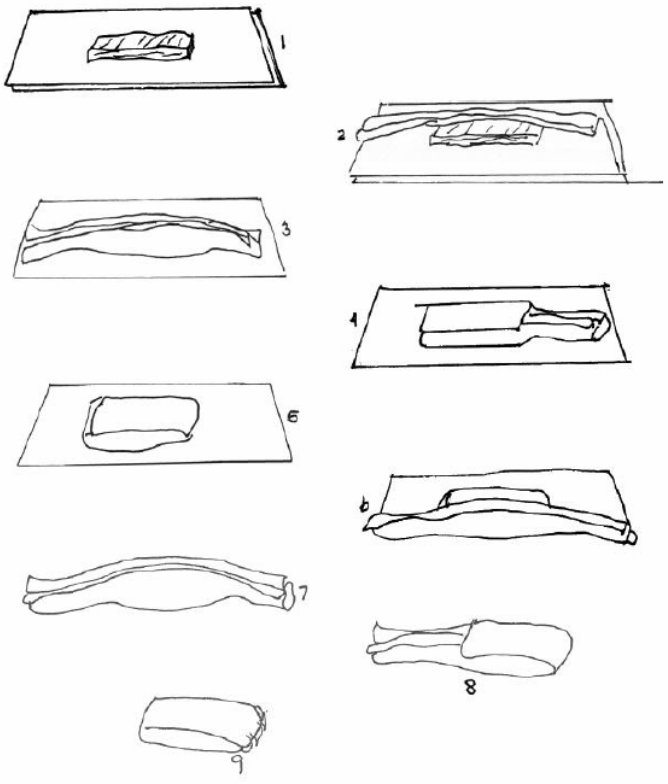
enough to hold the contents together and allow easy penetration of the sterilant.

Items are sequentially wrapped (double-wrapped); one layer at a time, in two separate pieces of textile or non-woven material. The outside wrapper provides a barrier to contamination during handling and acts as a barrier against insects, vermin, and dust. The inside wrap, when opened, may be used as a sterile field.

Proper folding of the wrapper is necessary to secure the package contents and to allow the package to be opened correctly without contaminating the contents. The two most common techniques used for wrapping packs and other medical items are:

- the square fold or straight method
- the envelope fold or diagonal method

SQUARE FOLD



SQUARE FOLD OR STRAIGHT METHOD OF WRAPPING

1. Place two wrappers lengthwise across the table.
2. Place the item in the center of the wrapper.
3. Fold the front edge of the wrapper over the item, covering half of it. Fold the edge back to form a cuff.
4. Fold the back edge of the wrapper over the item. Fold the edge back to form a cuff, overlapping the cuff of the front edge.
5. Fold the left edge of the wrapper over the item, covering half of it. Fold the edge back to form a cuff.

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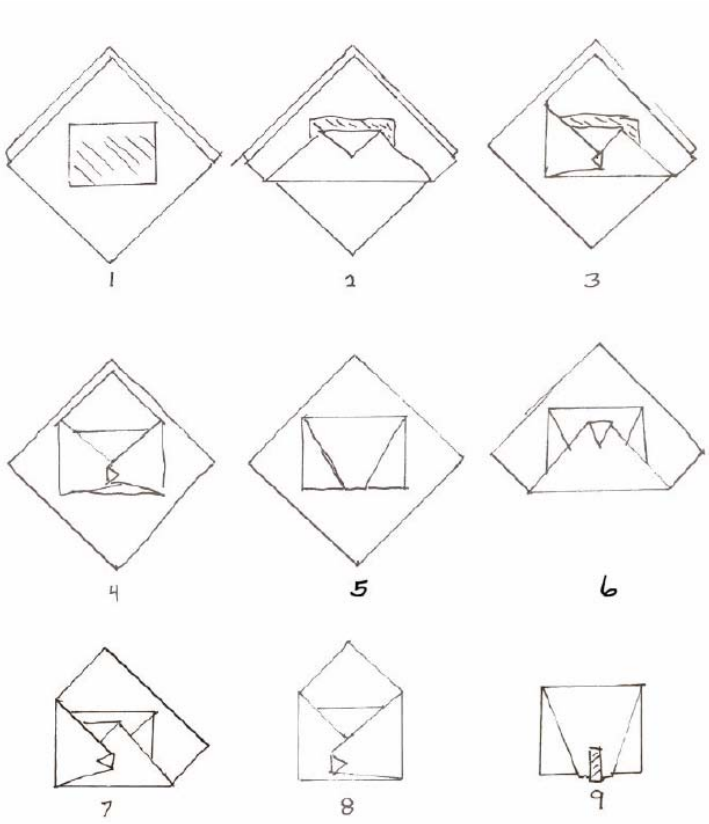
6. Fold the right edge of the wrapper over the item. Fold back the edge to form a cuff overlapping the previous fold.
7. Repeat the entire procedure with the second wrapper. Fold the front edge over and form a cuff.
8. Fold the back edge and form a cuff.
9. Fold the left edge and form a cuff.
10. Fold the right edge and, instead of forming a cuff, bring the edge up and over the item, and secure it with sterilization indicator (autoclave) tape.

ENVELOPE FOLD



ENVELOPE FOLD OR DIAGONAL METHOD OF WRAPPING

1. Place two wrappers diagonally across the table with one corner pointing to the edge of the table.
2. Place the item in the center of the wrapper parallel to the table edge.
3. Fold the forward corner of the wrapper up over the item, covering half of it. Fold the corner back to form a tab that will be used to open the package.
4. Fold the left corner of the wrapper over the item. Fold the tip back to form a tab.
5. Fold the right corner over the item, overlapping the opposite side. Fold the tip back to form a tab.
6. Fold the back corner of the wrapper over the item and previous folds and tuck the tip under the folds of the left and right corners, leaving a small tab visible for easy opening. *Repeat the process for the second wrapper.*

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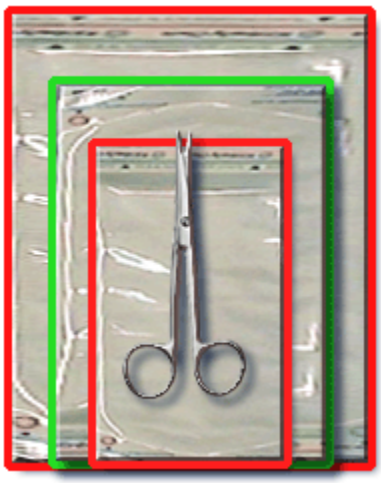
7. Start with the front corner … then the left corner … then the right corner … and finally the back corner. Instead of tucking the final corner under the others, bring it over the edge of the package and secure it with sterilization indicator tape.

Wraps should be done sequentially—one at a time—and secured with sterilization indicator tape. Use the tape as a place to label and initial the package. Once the package is processed, the tape changes color to indicate that the package has been subjected to sterilization conditions.

Packages should never be secured by string, paper clips, pins, staples, or other sharp objects that could penetrate the surface of the wrapper.

Pouches



Pouches, often called "peel packs" because of the way they are peeled open, are used for items that are too small to wrap or when it is important to be able to see the contents of a package. They are made from a variety of materials, including paper, polyethylene, cellophane, spun-bonded olefin, and various paper/plastic combinations. The most common are preformed paper/plastic with three sides pre-sealed. Choose a size that is right for the object being wrapped. If the pouch is too small it may bulge and burst; if it is too large, it will allow the item to move around and possibly be damaged.

Pouches may also come in rolls, with two sides pre-sealed. This allows you to cut the desired length, insert the item and then seal the top and bottom. A 1-inch section is required above the top seal to facilitate peel down. To provide for proper closure, seals should be at least 3/8 inches wide or double sealed.

Heat is the most common method for sealing pouches. The process bonds the plastic to the paper. After the seal is made you must inspect it to ensure that it is secure. There are several makes and models of heat sealers. Follow the manufacturer's directions for the model you are using.

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Some sealing machines operate at high temperatures and can cause burns.

Some pouches are "self-sealing." Paper backing is peeled from an adhesive strip on the flap and the end flap is folded over to close the opening. Place the package on a flat surface and fold the flap over carefully to avoid gaps or wrinkles, which allow microorganisms to enter.

Certain brands of pouches do not seal completely and should not be used. Be certain that any you use are approved for use.

DO NOT secure pouches with anything other than the recommended sealing method. Paper clips, pins, and staples will damage the package integrity. Items packaged in pouches for use in the operating room should be double packaged to allow for delivery to the sterile field. When placing items in a pouch, position them so that the end or handle to be grasped is near the opening of the package. This allows the user to remove the item without contaminating it.

Container Systems

Containers come in a variety of sizes. They are used for surgical instrument sets, small items, and some powered equipment. When using containers:

- Inspect the latches and seals
- Never overload containers
- Clear all items of the hinges and edges when closing
- Wipe down individual containers and process in a washer/decontaminator between uses.

Linens should not be sterilized in containers because there are no studies to support that this is effective.

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Labeling

All packages must be labeled in order to tell what is inside, who assembled the package, and when it was done. Proper labeling is necessary for quality assurance, inventory control, and maintaining sterility. Labels should include:

- package contents,
- technician initials,
- service name, and
- sterilizer lot control number which includes shelf life expiration date (added after sterilization).

Hand Written Labels

- ☑ Use felt-tip, indelible ink markers so that the ink does not run, fade, or transfer to the instruments.
- ☑ Record all required information on the tape. Never write on the wrapper.
- ☑ Write on the tape before you put it on the package to avoid damaging the package contents.

Preprinted Labels

- ☑ Indicator tape can be purchased preprinted with the name of high volume items such as towels and 4X4s.
- ☑ Label packages as soon as they are wrapped. If you delay there is a chance that something will be mislabeled.

Labels can be used to manage the shelf life of stored items. Shelf life is the time that an item is expected to remain safe for use. Several things can affect shelf life;

- storage conditions;
- climate and humidity; and
- access to the area.

Any item that has reached the end of its shelf life must be reprocessed and evaluated to determine if it is still needed and will continue to be stocked.

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Remember that sterility is event-related rather than time-related. Contamination doesn't suddenly occur on the last day of the labeled shelf life. Factors such as improper handling, inadequate cooling time after sterilization, excessive stacking of items, exposure to extreme climate conditions, the type of material used, and how well the package is sealed, all impact the sterility of an item.

Follow these guidelines for items with a low turnover rate.

Guidelines for Shelf Life	
Item	**Store for**
Woven and non-woven wrapped items with no dust cover	**30 days**
Woven and non-woven wrapped items with a dust cover	**1 year**
Paper/plastic peel pouch	**1 year**
Containerized systems	**1 year**
Commercially sterilized items	**Manufacturer Recommendations**

When an item reaches its expiration date it must be unwrapped and reprocessed.

Summary

Without adequate packaging, the best decontamination and sterilization techniques in the world are useless. Once an item is sterilized, it must remain that way until it is needed for patient care. Wrapped items must be properly handled and stored in order to preserve sterility.

To be effective, packaging material must:

- provide a barrier to dust and microorganisms

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- allow for adequate penetration of the sterilant and prevent *wicking* of moisture
- allow proper seals
- withstand normal handling and protect the product
- allow sterile presentation of the contents

SPD technicians are responsible for knowing the characteristics of the various packaging materials that are available to them and how to use them effectively.

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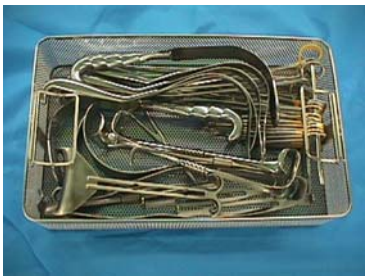
✓ Check What You Know

1. Match each term to its description.

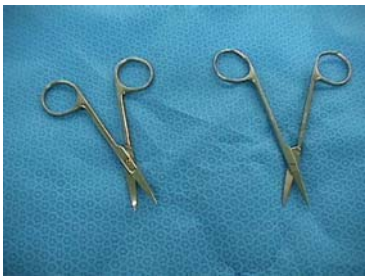
a. container systems	___ Provide more protection for delicate instruments
b. large linen wrap	___ Should be placed on the bottom shelf to avoid dripping condensation
c. peel pouches	___ Useful for packaging large, unwieldy objects such as basin sets
d. non-woven wraps	___ Useful when visibility of item is important
	___ Useful for procedure trays

2. How would you package these items?



Method _____

Method _____



Method _____

3. Where would you place this item on the sterilization cart?

_____

_____

_____

4. Which of the following can impact the sterility of an item? _____
   a. Handling
   b. Cooling time

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c. Storage conditions
d. Wrapping material
e. Sealing method
f. Expiration date

5. Most sterilized items should be reevaluated after _____ to determine if they are still needed and are stored in the appropriate location.
    a. their expiration date
    b. 1 month
    c. 6 months
    d. 1 year

6. Package labels should include:
    - ☐ Contents
    - ☐ Expiration date
    - ☐ Storage conditions
    - ☐ Technician initials
    - ☐ Sterilization method

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Module 5 - PACKAGING

1. WHEN USING MUSLIN WRAPS THE TECH SHOULD?

A. WRAP THE ITEM USING TWO WRAPS AT A TIME
B. SECURE THE WRAP WITH PAPER CLIPS
C. SEQUENTIALLY WRAP THE ITEM WITH ONE WRAP AT A TIME
D. NONE OF THE ABOVE

2. WHEN USING A CONTAINER SYSTEM FOR PROCESSING IT

A. SHOULD HAVE ANTI TAMPER LOCKING LATCHES
B. SHOULD BE PLACED ABOVE TEXTILES ON THE LOAD
C. HAVE A HOLE IN THE LID TO HELP THE STEAM GET INSIDE
D. NONE OF THE ABOVE

3. WHEN USING POUCHES/PEEL PACKS?

A. WRITE ON THE POUCH/PEEL PACKS
B. ENSURE THAT A CONNER OF THE POUCH IS LEFT UP FOR EASY OPENING
C. BE LEFT BLANK THE USER CAN SEE WHAT IS INSIDE
D. NONE OF THE ABOVE

4. BASIN SETS SHOULD BE CONSTRUCTED IN WHICH OF THE FOLLOWING WAYS?

A. SMALLER BASINS INSIDE OF LARGER ONES FACING IN OPPOSITE DIRECTIONS WITH A PIECE OF ABSORBENT MATERIAL IN BETWEEN.
B. SMALLER BASINS INSIDE OF LARGER ONES FACING IN THE SAME DIRECTION WITH A PIECE OF ABSORBENT MATERIAL IN BETWEEN.
C. SMALLER BASINS INSIDE OF LARGER ONES FACING IN THE SAME DIRECTION WITHOUT A PIECE OF ABSORBENT MATERIAL IN BETWEEN.
D. NONE OF THE ABOVE

5. ALL LABELING OF PACKAGING SHOULD HAVE

A. TECHS INITIALS, ITEMS NAME AND WHERE IT IS TO BE DELIVERED
B. ITEM NAME ONLY
C. TECHS INITIALS, ITEM NAME, LOT NUMBER WITH EXPIRATION DATE, AND WHERE IT IS TO BE DELIVERED.
D. NONE OF THE ABOVE

6. POUCHES/PEEL PACKS ARE USED FOR?

A. ITEMS TO LARGE TO WRAP
B. ITEMS THAT ARE TOO SMALL FOR WRAPPING
C. FOR EASY IDENTIFICATION OF THE ITEM INSIDE
D. A & C
E. B & C

7. PEEL PACKS/POUCHES HAVE A EXPIRATION DATE OF

A. ONE WEEK
B. ONE MONTH
C. ONE YEAR
D. TWO YEARS

8. ITEMS WRAPPED IN TEXTILES WITHOUT DUST COVERS HAVE A SHELF LIFE OF?

A. ONE WEEK
B. ONE MONTH
C. ONE YEAR
D. TWO YEARS

9. WHEN USING A CONTAINER FOR PROCESSING THE ITEMS SHELF LIFE IS?

A. ONE WEEK
B. ONE MONTH
C. ONE YEAR
D. TWO YEARS

10. A BIOLOGICAL MONITORING DEVICE SHOULD BE PROCESSED?

A. ONCE A WEEK
B. ONCE A MONTH
C. AT LEAST ONCE A DAY
D. ONCE A YEAR

11. WHAT ARE THE TWO PRIMARY WRAPPING DESIGNS IN SPD?

A. RECTANGLE, SQUARE
B. STRAIGHT, SQUARE
C. ENVELOPE, SQUARE
D. ENVELOPE, STRAIGHT

12. THE NORMAL THREAD COUNT FOR MUSLIN WRAPS IS?

A. ABOVE 200
B. 140- 180
C. 180-200
D. 140 OR LESS

13. A TEXTILE WITH A THREAD COUNT OF 140-180 IS CALLED?

A. MUSLIN
B. PERCALE
C. PIMA COTTON
D. NO SUCH THREAD COUNT EXISTS.

14. A DUST COVER WILL EXTEND THE SHELF LIFE OF AN ITEM FOR HOW LONG?

A. ONE WEEK
B. ONE MONTH
C. ONE YEAR
D. TWO YEARS

15. TRUE/FALSE A BIOLOGICAL INDICATOR MUST BE RUN WITH ALL IMPLANTS PROCESSED

TRUE - FALSE

16. BIOLOGICAL INDICATORS MUST BE READ WITHIN?

A 72 HOURS
B. 96 HOURS
C. 48 HOURS
D. ONE WEEK

17. IMPLANTS MUST BE HELD IN QUARANTINE FOR?

A. CAN BE USED RIGHT AWAY
B. THREE DAYS
C. 24 HOURS
D. 48 HOURS

18. TRUE/FALSE TOO MUCH WRAPPING IS AS BAD AS TOO LITTLE IN THE STERILIZATION PROCESS.

TRUE - FALSE

19. WHEN PUTTING A ITEM WITH A HANDLE INTO A POUCH/PEEL PACK

A. PUT IT IN HANDLE FIRST
B. MAKE SURE THE HANDLES ARE CLOSED
C. PUT IT IN HANDLE LAST
D. NONE OF THE ABOVE.

20. WHEN LOADING A MIXED LOAD OF CONTAINERS AND TEXTILES THE TECH SHOULD?

A. PUT TEXTILES ON THE BOTTOM OF THE LOAD
B. STACK THE CONTAINERS AT LEAST THREE HIGH
C. PUT CONTAINERS ON BOTTOM OF LOAD WITH TEXTILES ON TOP
D. MIX CONTAINERS AND TEXTILES THROUGHOUT LOAD.

Section Six: Sterilization

Estimated Contact Time:
1 ¾ - 2 hours

This module is designed to:

…. provide an overview of the sterilization process. It details the reasons for sterilization and the different methods of achieving it. You will become familiar with the types of sterilizers, their components, and how to effectively monitor sterilization cycles.

Following instruction, you should be able to:

- ☑ Identify types of sterilizers and their components.
- ☑ Identify and sequence the steps in sterilizer cycles.
- ☑ Identify EtO monitoring and personal protection requirements.

What is Sterilization?

The surfaces that we come into contact with during our everyday lives are teeming with microbial life. Even this page, though it looks clean, could harbor thousands of tiny, living organisms. While most of them are harmless, some could make you sick or even, given the right environment and time to grow, cause death. Sterilization completely destroys all forms of microbial life on a surface. It is an absolute. An object cannot be "almost," "practically sterile," or "sterile to a degree."

Because of the relationship of microorganisms to infection and disease (see Module 2, Microbiology) many of the supplies and medical devices that SPD manages must be sterilized. In SPD, sterilization is normally accomplished by one of two methods: saturated steam under pressure or gas. Two other methods, dry

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heat and chemical sterilization, exist, but are rarely used for terminal sterilization in VA.

Achievement of true sterilization is a function of probability, and the process is influenced by the laws of chance. There are many factors that can influence whether an item can be sterilized.

Factors Affecting Sterilization

- The number of organisms and their resistance to the sterilizing agent
- Debris, such as protein soil, oils, grease, or blood on the item that provides protection for the organisms.
- Proper loading techniques
- Functional efficiency of the sterilizing equipment
- Achieving required sterilization parameters
- Human performance—how well the people cleaning, packaging, and monitoring the sterilizers do their job
- Post sterilization handling techniques

There are several different types of equipment used to terminally sterilize medical supplies and equipment. Steam and ethylene oxide sterilizers are the two most commonly used in hospitals and clinics.

Steam Sterilization

For items that can withstand high temperatures and moisture, steam is one of the most reliable methods for sterilization. Steam is very effective in killing microorganisms. It is relatively easy to produce, inexpensive, and the process can be effectively monitored. Steam sterilizers use moist heat, in the form of saturated steam under pressure, to destroy microbial life forms, including viruses and spores. The steam coagulates the microorganism's *cytoplasm* and damages the cytoplasmic membrane, killing the cell. Microorganisms can be killed using heat alone, but the addition of water vapor, in the form of steam, allows the process to work at lower temperatures with less exposure time. This helps to extend

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the life of medical devices, which must be subjected to repeated sterilization cycles.

Did you know?

The coagulation of the microorganism's protoplasm can be compared to the chemical change that occurs in the white of an egg when it is poached.

Three factors affect the steam sterilization process.

- Surface contact
- Time and Temperature
- Temperature and Pressure

Surface Contact

For the steam to effectively kill all microorganisms on a surface, it must contact the entire surface. Sometimes there are barriers such as; bubbles of air, debris left from improper cleaning, obstructions due to overloading or improper packing.

Time - Temperature Relationship

In order to kill some of the most resistant forms of microbial life, the sterilization process must continue for a minimum time at a steady temperature.

30 - 45 minutes
@ 250 degrees F
or
3 - 5 minutes
@ 270 degrees F

As the temperature increases, the kill time decreases. The total exposure time equals the heat up time, plus the kill time, plus the safety factor. The heat up minutes are the time required for the load contents to come to the desired temperature, AFTER the chamber has reached the selected sterilizing temperature and all the air has been removed from the chamber. Kill time is the recommended time that the sterilizer must remain at the designated temperature in order for the microorganisms to be eliminated. Safety factor minutes are factored in to provide a margin of error.

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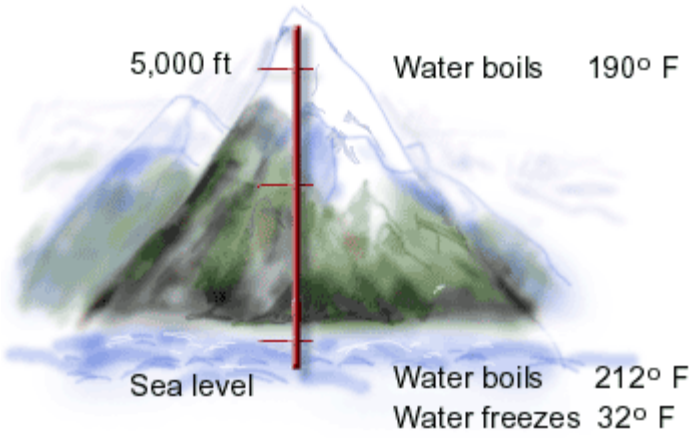
Temperature—Pressure Relationship



For proper steam quality there is a constant relationship between temperature and pressure. Pressure is used to help increase the temperature in the sterilizer chamber. At sea level, water freezes at 32 degrees F and boils at 212 degrees F. At an elevation of 5,000 feet above sea level, water will boil at approximately 190 degrees F because of the lower pressure. Depending on pressure, water will boil anywhere from 35 degrees F to 704 degrees F. By raising the pressure of the saturated steam, the sterilizer is able to reach the kill-temperatures necessary to destroy the most resistant forms of microbial life.

Did you know?

Geographic location can also affect the pressure required. Pressure must be increased by .5 pounds for each 1,000 feet above sea level. The increased pressure compensates for the decreased atmospheric pressure.

Steam Quality

The quality and purity of the steam can affect the sterilization process. Steam quality refers to the amount of moisture in the steam. The steam used in sterilization is saturated steam. It is 97 percent dry with 3 percent moisture content. Saturated steam has a constant relationship between temperature and pressure. The temperature of saturated steam cannot be reduced or increased without a corresponding reduction or increase in pressure. When you increase the temperature of saturated steam without increasing the pressure, it becomes superheated steam. Superheated steam is "dried out" and does not have the moisture content that is required for effective steam sterilization.

Wet steam occurs when the temperature of saturated steam is decreased without the corresponding drop in pressure. Wet steam may occur at peak operation periods when excessive demand on

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the boiler may lower temperatures, when improper trapping of the steam line to the sterilizer permits a moisture buildup in the lines immediately adjacent to the unit, or an uninsulated line allows the steam to cool. Steam with a high moisture content can cause wet packs in the sterilization process.

Sterilization can also be affected by impure steam, which contains solid, liquid, or vapor contaminates.

- Rust, pipe scale deposits, sludge, or particles can cause solid impurities from gaskets.
- Liquid additives that are used to control the pH level and retard scale and corrosion in the boiler feed water can show up in the steam.
- Volatile amine additives, which are used to prevent corrosion in steam and condensate return lines, can vaporize and become mixed with the steam.

Steam can also pick up additives from linen wrapping materials that have been improperly rinsed or treated with chemicals.

Since it does not contain microorganisms, the steam may be considered sterile, but it is far from "pure." Impure steam can cause linen spotting and instrument staining. If problems arise that appear to be caused by steam impurity, it is important to discuss the problem with Engineering Service, boiler maintenance workers, the sterilizer manufacturer, or the laundry plant manager, in order to determine the source of the problem.

Steam Sterilizer Equipment

Steam sterilizers can come in different sizes, from large floor models to units capable of handling only a few supplies. The sterilizer unit is connected to a steam feeder system and a steam condensing system that converts the steam into water following the sterilizing operation.

The body of the sterilizer can be encased in a stainless steel cabinet; however, the plumbing and the body of the sterilizer are usually housed in a dedicated room with only the door, control panel, and

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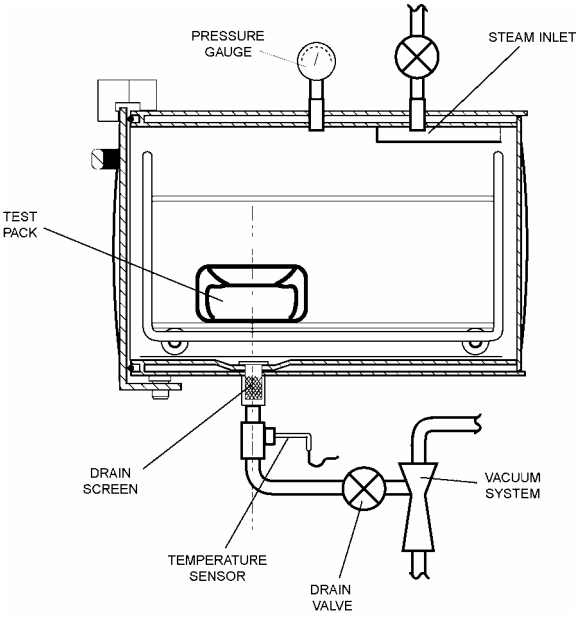
gauges visible to the staff. Though manufacturer and model may vary, most steam sterilizers have basically the same components;

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 (with prevacuum units)



Processing temperature for steam sterilizers ranges from 250 degrees F to 275 degrees F. There are two basic cycle types; gravity displacement and pre-vacuum.

Pre-vacuum

In the pre-vacuum cycle, steam is injected only into the jacket until the proper pressure is reached. This prevents condensation from forming on the cool chamber walls. The conditioning phase involves an initial purge during which steam is forced in, pushing air out through the chamber drain. A series of steam pulses and

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vacuum pulls follows. During the steam pulse, the chamber valve closes and steam is injected through the steam inlet valve. During the vacuum pull, the steam inlet valve closes and air or steam is pulled from the chamber by a powerful vacuum system, which creates a negative pressure within the sterilizer chamber. The pulse/pull sequence consists of three steam pulses and four vacuum pulls. After the last pull, there is negative pressure within the chamber. When steam is introduced it penetrates the chamber and contents very quickly, in a turbulent manner since it is not impeded by air.

Once the thermometer reaches the pre-selected temperature, the steam inlet valve and the chamber drain close and the exposure time begins. If the temperature drops during the exposure cycle, the steam valve opens and steam again enters the chamber until the temperature returns to the selected level.

After the preselected exposure is complete, the steam is removed from the chamber by the vacuum system. Sterile filtered air is mechanically injected into the chamber to relieve the vacuum. When the cycle is complete, the door is opened and the cart of items is moved to the cool down area.

Gravity Displacement

In a gravity displacement sterilizer, steam is injected into the jacket until the proper pressure has been reached. This heats the chamber and prevents condensation from forming on the interior walls and wetting the load. With the drain open, the cycle is initiated and steam is injected through the inlet valve. Because air is nearly twice as heavy as steam, it is pushed or displaced to the bottom of the sterilizer and flows out through the chamber drain line. It is important to remember this top to bottom flow when loading the sterilizer. If items are loaded incorrectly, air may become trapped, preventing the sterilant from contacting all surfaces.

When the thermometer in the chamber drain line reaches the preselected temperature, the steam inlet valve and the chamber drain valve close and a timing mechanism tracks the preselected exposure time. If the temperature drops during the exposure cycle, the steam valve will reopen and add steam until the proper

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temperature is achieved. During the exhaust phase, steam is quickly exhausted and sterile, filtered air is injected to cool and dry out the load. After the exhaust phase, the chamber door is opened slightly to continue the drying process. At the end of the drying cycle the contents are removed and placed in the cool down area.

Testing Sterilizer Function

The Bowie-Dick test is performed on pre-vacuum sterilizers to test the effectiveness of the vacuum system. The test consists of a package of chemical indicator that changes color in an effective vacuum.

The Bowie-Dick test is performed daily according to the manufacturer's instructions. Test packs must be placed in an empty sterilizer, on the bottom rack of the sterilizer, near the drain. This is the most difficult area in the chamber for creating an effective vacuum.

Table Top Sterilizers

Tabletop steam sterilizers are gravity-displacement sterilizers that are small enough to be placed on a counter. They are usually found in dental offices or clinics. The unit contains an electric generator that turns water into steam, which is injected into the chamber for a predetermined time.

Did you know?

Fabric wraps should not be ironed because ironing causes the weave to tighten, inhibiting steam penetration. Ironing also dries out the fabric, causing it to absorb excess amounts of moisture, which results in superheating. Superheating can cause fabrics to scorch or burn. Fabrics should be laundered and rehydrated between each sterilization process or if the item becomes outdated on the shelf.

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Ethylene Oxide (EtO) Sterilization

Ethylene oxide sterilization has been used effectively to sterilize heat and moisture sensitive medical devices for more than a half century, but because of the toxic nature of the gas, its use must be carefully controlled and monitored. EtO sterilization functions through alkalization, which causes a chemical interference in the cell, disrupting the reproductive process. EtO is expensive and time consuming and should be used ONLY for heat sensitive items that cannot be sterilized using steam.

If water and EtO mix during the sterilization cycle, a by-product, polyglycol is produced. This byproduct can be hemolytic—it destroys blood cells. Always assure that items have been properly dried prior to sterilization.

There are two commonly used types of ethylene oxide sterilizers. Full size units are often housed in a separate room or enclosure. They use a mixture of EtO and carrier gas such as Hydrochloric Fluorocarbon (HCFC) or Carbon Dioxide. Tabletop units are small chamber stand-alones that use 100% EtO cartridges. Both require a well-designed ventilation system.

Because of Federal mandates involving the release of chlorofluorocarbons (CFC's) into the atmosphere, EtO mixtures containing Freon will no longer be used.

The basic EtO sterilization process has four phases:

1. The vacuum phase removes most of the residual air from the chamber and the packaged items.

2. Once sufficient vacuum has been accomplished, humidity is injected into the chamber for a 20- to 30-minute conditioning period. It diffuses throughout the load, bringing the contents of the load to the desired temperature and a relative humidity of 50 to 75 percent.

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3. The ethylene oxide gas is pumped in under pressure, and the chamber pressure rises, helping to achieve sterilization. The sterilizer remains in this "exposure" phase for the preset amount of time, with the chamber maintained at constant pressure, humidity, and temperature.

4. Once this phase is completed, a second vacuum cycle removes the gas from the chamber and exhausts it to the outside atmosphere. Air is drawn in through a bacteria retentive filter and then re-evacuated from the chamber, removing most of the ethylene oxide. This is known as the "purge" cycle. This air wash usually lasts for 10 to 30 minutes, but some sterilizers continue the filtered air purge until the door is opened.

The parameters that can impact the success of this sterilization process are time, temperature, moisture, and the concentration of the sterilizing agent. A typical cycle is 2 hours at 130° F. A cold cycle can be run at 100° for 4 hours to process items that cannot withstand the higher temperature.

Loading and Unloading the EtO Sterilizer

Place items to be sterilized on metal sterilizer carts or in wire baskets to minimize handling and allow safe transfer of items from the sterilizer to the aerator. Arrange items loosely on the cart to ensure that the sterilant has access to all surfaces. Do not allow them to touch the sterilizer chamber walls during the sterilization process.

Aeration

All items sterilized by EtO must be aerated. Items that are not properly aerated can cause burns to the patient, physician, or staff handling the item. Many EtO sterilizers are equipped with an aeration cycle at the end of the sterilization cycle. This allows the load to completely aerate, removing all traces of EtO gas prior to opening the door or touching the items. This is the safest way method. If there is no aeration cycle, the sterilizer door must be cracked open for 15 minutes prior to beginning the unloading process. All staff should remain away from the area during this time.

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If the sterilizer does not have an aeration cycle, you may have to remove the sterilizer load and place it in a separate aerator. Pull the cart to the aerator, slide the load in, close the door and begin the cycle immediately. A minimum aeration cycle is 12 hours at 122 degrees F, but always consult the manufacturer's instructions for specifics.

Room or ambient aeration (where the sterilized items are placed in an isolated, well-ventilated room until the gas dissipates) is not recommended.

Personnel Monitoring

EtO is a colorless gas with an ether-like odor. Coming into contact with EtO has caused cancer in laboratory animals and been associated with higher incidents of cancer in humans. Additional side effects of exposure to EtO include adverse reproductive effects, chromosome damage, and neurotoxicity. In its liquid form, EtO exposure can cause eye irritation, lung injury, headaches, nausea, vomiting, diarrhea, shortness of breath, and cyanosis. Monitoring activities are recommended in areas where EtO is used.

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. These limits include:

- **Permissible Exposure Level (PEL)**
  The individual Permissible Exposure Level has been set by OSHA to ensure that no employee has been exposed to airborne concentrations in excess of 1 part per million (ppm) parts of air during an 8-hour Time Weighted Average (TWA) period. If the EtO concentration level in an area exceeds the PEL, a respirator must be worn until the problem is corrected.

Level	Limit
PEL	< 1ppm in 8 hour TWA
ACTION	.5 ppm in 8 hour TWA
STEL	5 ppm in 15 minute period

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- **Action Level**
  The action level is the point at which you must take action to avoid reaching the permissible exposure level and is usually set at half the PEL. For EtO it is .5 ppm in an 8 hour TWA. If an employee is exposed at or above the action level they must be monitored again in 6 months.

- **Short Term Excursion Limit (STEL)**
  The STEL requires that no employee be exposed to an airborne concentration of EtO in excess of five parts of EtO per million parts of air (5 ppm), averaged over a 15-minute period. STEL monitoring is done during those times when the possibility of exposure is high, such as during tank changes, purge, or exhaust cycles. If the 15-minute STEL is above 5 ppm, the exposure problem must be remedied and monitoring must be repeated until two consecutive measurements, at least 7 days apart, are below the STEL action level of .5.

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.

Individuals who work in the EtO area must wear monitoring badges to keep track of their exposure. Monitoring must be done at least twice, seven days apart. If the readings are below the action level, monitoring can be discontinued until there is a change, such as equipment repair or replacement, or change of procedure. If the reading is above the action level, but below the PEL, monitoring must

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be repeated every six months.

A medical surveillance program, that includes a medical examination and consultation, must be in place and available to all employees who are or may be exposed to EtO for at least 30 days a year. Medical exams are available to employees

- prior to assignment in SPD
- at the termination of employment in SPD
- at least annually
- as soon as possible after potential exposure to EtO
- at the employee's request, as medically appropriate, for any exposure.

Area Monitoring

Two alarm systems are required by OSHA;

- An EtO emergency alarm that is designed to avoid exposure above the STEL level.

- A ventilation alarm alerts personnel if there is a malfunction in the ventilation system.

In addition, some medical centers have another alarm system to detect high EtO levels in the work area before employees are exposed to them. Most systems have both a low and a high alarm which are set at or below OSHA exposure levels. 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 PEL of 1 ppm. In the tank room and equipment maintenance access areas, the STEL is 5 ppm, so the alarm should be set at this level to notify anyone working there to evacuate immediately.

Alarm Levels	
Low Alarm Level	.5 ppm
High Alarm Level	1 ppm
Tank and Equipment Area	5 ppm

Placement of the sensing ports for the monitoring system is important. There should be a monitoring point:

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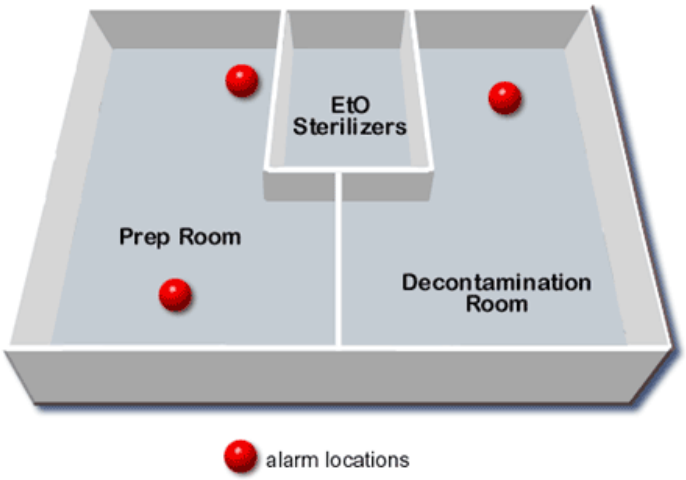
- directly in front of the EtO sterilizer,
- at the work stations in the preparation room,
- directly in front of the sterilizer in the Decontamination room.



Changing the EtO tanks and moving items from the sterilizer to the aerator represent a high risk EtO exposure and require increased precautions. Personal protective clothing must be worn when changing EtO tanks, whether they are 100% EtO cartridges or mixture EtO tanks.

PPE for changing tanks includes:

- impermeable coveralls
- butyl gloves
- head coverings
- full face piece respirator (SCBA)

EtO Precautions

In addition to protective clothing, working with EtO requires a number of additional precautions. Liquid EtO is easily ignited.

- Care should be taken to prevent any sparks or exposure to heat, flames, or other items that might cause the EtO to ignite.
- Non-sparking tools should be used when opening or closing metal containers of EtO.
- If impermeable clothing or skin becomes wet with liquid EtO, immediately enter a shower and remove the clothing.

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EtO is a hazardous substance that is highly flammable. Use caution when handling. Fire extinguishers and showers should be readily available, and SPD technicians must know where they are and how to operate them.

EtO must be properly stored and handled to reduce the risk associated with its use. Storage guidelines must be strictly followed.

100 percent EtO Cartridges	No more than a three-day supply—up to 12 fifty-gram cartridges—may be stored in the sterilizer area. If more than 48 cartridges are required in inventory, the storage area must conform to National Fire Protection Association (NFPA) recommendations. Containers containing EtO must be returned to the manufacturer or disposed of in accordance with the manufacturer's instructions and in compliance with EtO health and safety requirements, and applicable local regulations.
EtO Gas Mixture Cylinders	Cylinders of EtO gas mixtures, such as 10/90, 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 that have been used and removed from service are handled in the same manner as full cylinders.

Mandatory Annual EtO training

Each SPD employee is required to attend annual training on EtO, which includes:

- 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
- professional EtO monitoring methods

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The SPD Chief will develop a local policy, with concurrence by the Industrial Hygienist, indicating what steps should be taken in the event of an EtO emergency.

Plasma

Plasma sterilizers operate by vaporizing a chemical compound and passing it through an electromagnetic field, which strips electrons from some of the atoms and accelerates the particles. This creates particles that kill microorganisms (including bacterial spores) by disrupting their cell membranes. The chamber size varies from 2.5 to 5.0 cubic feet and the sterilization cycle takes about one hour. There is no residual from the chemical, so aeration is not required. Plasma sterilizers are useful for sterilizing rigid and flexible scopes, surgical and microsurgical instruments, surgical power equipment, and glassware.

Plasma sterilizers are not designed to sterilize cellulose-based items such as linen and paper.

Dry Heat

Dry heat sterilizers are not used in VA medical centers because there is no way to validate and maintain the sterility of the items. On rare occasions, you may be asked to sterilize powder substances, like talc, which require dry heat. Do not comply with this request. Recommend that the user order the powder pre-sterilized from the vendor.

Did you know?

Liquids will not be sterilized in VA facilities because there is no way to confirm that liquids are sterile or that the sterilization process has affected them.

Chemical

While chemicals are most often used for high level disinfection, chemical sterilizers do exist. They use peracetic acid and sterile water to clean and sterilize heat sensitive, immersible items such as flexible and rigid scopes and microsurgery instruments. They operate at 50 - 55.5 degrees C and achieve sterilization in 20 - 30 minutes. The equipment consists of a processor unit, a control panel, a recording/printing device and various sized inserts and

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instrument trays. These sterilizers are relatively small and are limited by the fact that there is only room for one scope or small instrument tray at a time. The containers used cannot be sealed, so the sterile item must be used immediately.

Flash

Flash sterilization should only be used in emergency situations. This includes items that are dropped and single instruments that may be called for during a case.

If a specific instrument set is needed for another case on the same day, there must be enough time to send the instruments to SPD for decontamination and sterilization. Instruments should not be cleaned in the operating room by scrub nurses, and then flashed. This practice will lead to cross-contamination, and can cause grave patient outcomes. It is the responsibility of the Chief of SPD, and the Operating Room Manager to determine if additional sets of instruments must be purchased to avoid this situation. Under no conditions should implants, instruments with lumens, power equipment, or large trays of instruments be flash sterilized.

Flash sterilizers are basically gravity displacement sterilizers set on the "en" or non-wrapped cycle. When using one, you must place items in the tray so that they are not crowded. Do not use towels for cushioning.

Verifying Sterility

Sterilization is a complex process and since the only way to measure sterility is to test a surface to determine if there are living microbes present, there is no practical way of proving that an item is sterile without contaminating it. We rely on biological, chemical, and mechanical tests to verify that an item has been exposed to a processing cycle in a sterilizer.
Sterilization records must be kept for a minimum of 3 years. All records for an individual sterilizer should be stored together.

Biological

A biological indicator contains live spores. They are present in greater concentration than might be found on an item that has been through the decontamination process. If the sterilization process is

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sufficient to kill the high concentration of spores in the indicator, then it will be more than enough to eliminate any bioburden on items in the sterilizer load.

Biologic indicators must be incubated for 48 hours and examined for color change to determine if the bacteria are viable. The presence of live bacteria in the test sample indicates that the sterilization process was not effective. If there is no color change, then there is no bacterial growth and sterility was achieved. For steam sterilizers, biologic testing must be conducted:

- once a day in a full load
- in every load that contains an implant
- after any sterilizer repairs

Incubation is conducted at 55 degrees C. For EtO tests, incubation is at 37 degrees C and testing must be conducted in every load. A control indicator (unsterilized test vial) must be incubated daily for each type of sterilizer to ensure that the test bacteria are viable. The control indicators must be from the same lot number as the tests used in the sterilizers for that day.

Did you know?

Genobacillus Stearothermophilus (Bacillus stearothermophilus) are the spores used in steam sterilization. Bacillus Atrophaues (Bacillus subtilis) are used in EtO sterilization.

A positive biologic indicator doesn't necessarily mean that the sterilization cycle failed. Positive tests can also be caused by user error or contamination following processing. Regardless of the cause, if a positive test indicator is found, all items processed in the sterilizer since the last known good biologic indicator must be recalled and all items unwrapped, reprocessed and resterilized.

Chemical

Chemical indicators are made of paper that has been chemically treated to change color when it is subjected to the sterilization process. They are used both inside and on the outside of wrapped packages of supplies. External chemical indicators are placed on the outside of every package and are often used to hold the package

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closed. When used inside the package, their presence does not guarantee that package contents are sterile, but indicates to the user that the contents of the package were subjected to sterilizing conditions. If the indicator has not completely changed color, the contents may not have been subjected to a full scale sterilizing process and, therefore, should not be considered sterile. External indicators must be examined for complete color change after sterilization before placing the lot number on the package and again before the item is distributed.

Mechanical

Mechanical monitoring tracks sterilization parameters. Gauges, graphs, and recorders are used to ensure that optimum sterilization conditions were met. Sterilizers automatically generate a printout or graph of the cycle length, temperature, and pressure that the operator must verify. Sterilizers without this feature should not be used. Sterilization records must contain:

- Contents of the load
- Operator
- Date and time
- Cycle length
- Temperature

Sterilizing Implants

Implantable devices, or "implants," are items that will be surgically implanted and totally contained in the body (covered with tissue).

Examples include;

- orthopedic hardware items such as pins, screws, nails, rods
- total joint system replacement hardware
- heart valves
- cranial shunts and reservoirs
- breast and penile prostheses
- micromesh
- vascular grafts

Every sterilizer load containing an implantable device must be monitored using the appropriate biological indicator. Implants

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must be quarantined for 48 hours in order to allow time for the biologic test to be cultured and the sterilization confirmed. If an emergency situation occurs, SPD will process the implant as usual and, if an early release is necessary, the Chief of SPD must obtain a written approval from the Chief of Staff in order to release the implant from quarantine.

Reprocessing implants may occasionally be necessary. It is important to follow the manufacturer's guidelines in order not to compromise the implant. Some manufacturers require special gloves and aseptic cleaning procedures when handling implants. 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 safely be reprocessed. 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.

Implantable devices **will not** be processed by flash sterilization.

The Food and Drug Administration (FDA) mandates that certain medical devices be tracked so that they could be located, if it was necessary to provide their users with notification regarding health risks. This includes implants, both in use and in stock. SPD employees must be familiar with the Safe Medical Device Act tracking program that is in use in the medical center where they work.

Processing Loaner Instruments

The Chief of SPD must establish a protocol for handling instruments that are on loan. Loaner instruments must be obtained far enough in advance to allow them to be processed. You must have a count sheet for all loaner instruments.

If the same instruments are needed for multiple cases in a single day, the cases must be scheduled to allow enough time for the

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instruments to be reprocessed. The Chief of SPD must work with the Operating Room Manager to determine when additional sets of instruments must be purchased in order to avoid having to reprocess instruments for same day use. Instruments must not be cleaned and flashed in the operating room by scrub nurses. This can lead to cross contamination, and cause grave outcomes with the patient.

Summary

Sterilization is a critical component of the SPD mission. It is an absolute state—either something is sterile or it is not sterile. Sterilization can be affected by a number of factors;

- the number and type of microorganism,
- presence of debris,
- loading techniques,
- efficiency of the equipment, and
- post sterilization handling.

There are a number of different types and models of sterilizer. You must become familiar with the operation of the equipment that is specific to your work location.

You must also be familiar with the local policies governing the processing of implants and loaner equipment.

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✓ Check What You Know

1. How can you prove that something is sterile?
    a. Examine the label
    b. Check the chemical indicator
    c. You can't
    d. Look it up on the sterilizer log

2. What is the purpose of the Bowie Dick test?
    a. Ensure sterilization occurs
    b. Check the efficiency of the sterilizer
    c. Ensure that effective vacuum is achieved
    d. Check for air displacement

3. What factors can affect the steam sterilization process?
    a. time
    b. temperature
    c. surface contact
    d. pressure

4. Order the steps in the steam sterilization process.
    a. conditioning
    b. exposure
    c. come down
    d. drying

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5. Following EtO sterilization, why is aeration important?
    a. Residual EtO can cause burns to the patient, physician, or staff
    b. It speeds up the sterilization process
    c. It removes excess moisture, reducing the risk of polyglycol forming
    d. It removes all excess EtO from the items

6. Order the steps in the EtO sterilization process.
    a. Remove residual air
    b. Inject steam and bring to required temperature and humidity
    c. Inject EtO gas under pressure
    d. Exhaust gas and purge chamber

7. Match the term to its limit.

PEL	5 parts EtO per million parts of air in a 15 minute period
Action Level	One part EtO per million parts of air over an eight hour period
STEL	Usually half the permissible exposure limit

8. What types of monitoring are used in the medical center sterilization process?
    a. Chemical
    b. Biological
    c. Remote
    d. Mechanical

9. The cycle phases for a prevacuum sterilizer include conditioning, three _____ _____ and four _____ _____, followed by exposure and then the _____ of filtered air.

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10. Standard aeration times, as outlined in MP-2 Subchapter E, subpart 108-76.303(c), are: 50o Centigrade (122 degrees F) for _____ hours.

11. Liquids must
    a. be tightly sealed before sterilization
    b. not be mixed in sterilizer loads with other items
    c. not be sterilized in VA facilities
    d. carefully monitored to prevent flashback.

12. Steam sterilization is the best method for:
    a. anything that is needed in a hurry
    b. all reusable items
    c. items that can withstand heat and moisture
    d. plastic and rubber items

13. Which form of sterilization is known to be harmful to the ozone layer?
    a. Steam
    b. EtO
    c. Plasma
    d. Flash

14. Standard steam sterilization time is:
    a. 250 degrees F for 30 minutes
    b. 270 degrees F for 4 minutes
    c. 130 degrees F for 1 hour and 45 minutes
    d. 100 degrees for 4 hours

15. When loading sterilizers;
    a. Always put the larger items on top

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b. Place items so that they overlap

c. Avoid allowing items to touch the sterilizer walls

d. Leave at least one shelf empty to prevent condensation

16. Chemical indicators are used for:

a. ensuring that items are sterile

b. indicating that an item has been exposed to the sterilization process

c. preventing bleed through or wicking

d. overriding biological indicators.

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17. Biologic controls must be run

    a. In every load
    b. Once a week or more, as needed
    c. At least once per day when the sterilizer is in use
    d. Whenever a problem is detected or suspected

18. When can items be removed from the aerator

    a. Only when the aeration cycle is complete
    b. Before the aeration cycle finishes with a signed release from the Chief of SPD
    c. When something is needed in the O.R.
    d. 6 - 8 hours after processing

19. What is the Action Level for EtO exposure?

20. What is STEL and what are the limits?

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Terminology

The following terms were used in this module.

aeration	The process of circulating air through a processed sterilizer load
aerator	A device designed to circulate air through a loaded sterilizer cart
ambient aeration	The process of pulling an EtO processed load out into a room and allowing the EtO to dissipate into the air over time
biological indicators	A small glass or plastic vial containing a sample of bacteria, whose temperature and pressure tolerances are known, used to determine the effectiveness of a sterilization cycle The sample is processed along with the sterilizer load and is then cultured in the laboratory for 48 hours to determine if any of the bacteria survived
control indicator	A biological indicator that is cultured without being subjected to the sterilization process in order to determine that the bacteria in that lot number is alive
exposure time	The heat up time, plus the kill time, plus the safety factor
spores	A primitive, unicellular body produced by plants and some microorganisms that is capable or developing into another individual being
sterile	a condition absent of microscopic life
SCBA	SCBA—Self contained breathing apparatus
TWA	Time weighted average. The average amount of an allowable substance in a specified period of time.

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Module 6 - STERILIZATION

1. TRUE/FALSE STERILIZATION COMPLETELY DESTROYS ALL FORMS OF MICROORGANISMS INCLUDING SPORES.

TRUE - FALSE

2. WHAT ARE THE TWO METHODS OF STERILIZATION USED IN SPD FOR TERMINAL STERILIZATION?

A. GAS, CHEMICAL
B. DRY HEAT, STEAM
C. GAS, STEAM
D. NONE OF THE ABOVE

3. FOR ITEMS THAT CAN WITHSTAND HIGH TEMPERATURES AND MOISTURE THE MOST RELIABLE METHOD OF STERILIZATION IS?

A. GAS
B. CHEMICAL
C. STEAM
D. HAND WASHING

4. THE FACTORS THAT AFFECT THE STEAM STERILIZATION PROCESS ARE?

A. SURFACE CONTACT
B. TIME AND TEMPERATURE
C. TEMPERATURE AND PRESSURE
D. ALL OF THE ABOVE

5. THE PROCESSING TEMPERATURES FOR STEAM STERILIZATION RANGES FROM?

A. 175-275F
B. 275-350F
C. 225-250F
D. 250-275F

6. THE BOWIE DICK TEST IS PERFORMED ON A PRE-VACUUM STERILIZER TO TEST WHAT?

A. THE QUALITY OF THE STEAM
B. THE VACUUM OF THE SYSTEM
C. THE TEMPERATURE OF THE STEAM
D. THE PRESSURE OF THE STEAM

7. EtO STERILIZATION IS

A. USED FOR HEAT AND MOISTURE SENSITIVE DEVICES
B. IS TOXIC AND REQUIRES CAUTION IN ITS USE
C. EXPENSIVE
D. TIME CONSUMING
E. ALL OF THE ABOVE

8. EtO REQUIRES AERATION FOLLOWING THE STERILIZATION PROCESS

TRUE - FALSE

9. WHICH OF THE FOLLOWING AGENCIES SET THE REGULATION FOR EtO?

A. CDC
B. EPA
C. FDA
D. NOBODY REGULATES EtO USAGE

10. BIOLOGICALS SHOULD BE PLACED WHERE IN A LOAD?

A. THE FRONT
B. THE TOP
C. THE BACK
D. THE CENTER

11. BIOLOGICAL INDICATORS FOR STEAM STERILIZERS MUST BE CONDUCTED AT LEAST/

A. ONCE A WEEK
B. ONCE A YEAR
C. ONCE A DAY AND WITH EACH IMPLANT
D. NONE ARE NEEDED

12. TRUE/FALSE CHEMICAL INDICATORS ARE USED TO TELL IF AN ITEM IS STERILE OR NOT.

TRUE - FALSE

13. IMPLANTS MUST BE MONITORED BIOLOGICALLY AND THE IMPLANT QUARANTINED FOR?

A. 24 HOURS
B. 48 HOURS
C. 36 HOURS
D. 96 HOURS

14. STEAM STERILIZATION USES SATURATED STEAM THAT IS?

A. 97% DRY 3% MOISTURE CONTENT
B. 97% MOISTURE CONTENT 3 % DRY
C. 50% MOISTURE CONTENT 50% DRY
D. 100% MOISTURE CONTENT 100% DRY

15. SHORT TERM EXPOSURE LEVEL IS AN AIRBORNE CONCENTRATION OF EtO IN EXCESS OF?

A. 5 PARTS EtO PER MILLION PARTS OF AIR IN A 15 MINUTE PERIOD
B. 1 PART EtO PER MILLION PARTS OF AIR OVER 8 HOURS
C. 1 PART EtO PER MILLION PARTS OF AIR IN A 15 MINUTE PERIOD
D. NONE OF THE ABOVE

16. WHAT ARE THE TYPES OF MONITORING USED IN THE STERILIZATION PROCESS?

A. CHEMICAL, ELECTRICAL, MECHANICAL
B. ELECTRICAL, CHEMICAL, BIOLOGICAL
C. BIOLOGICAL, CHEMICAL, MECHANICAL
D. ELECTRICAL, NUCLEAR, BIOLOGICAL

17. TRUE/FALSE THE BIOLOGICAL INDICATOR AND THE CONTROL INDICATOR MUST BE FROM THE SAME LOT.

TRUE - FALSE

18. TRUE/FALSE DRY HEAT STERILIZERS ARE USED THROUGHOUT THE VA SYSTEM

TRUE - FALSE

19. THE BOWIE DICK TEST MUST BE PERFORMED HOW OFTEN?

A. TWICE A DAY
B. ONCE A WEEK
C. ONCE A MONTH
D. ONCE A DAY

20. IF MECHANICAL REPAIRS ARE PERFORMED ON YOUR STERILIZER WHAT DO YOU NEED TO DO?

A. NOTHING IF IT WORKS IT WORKS
B. CONTACT THE VENDOR AND LET HIM KNOW HIS STERILIZER HAS BROKEN DOWN BUT IT IS OKAY NOW.
C. SPD MUST RUN A SERIES OF VALIDATION TESTING BEFORE THE UNIT CAN GO BACK ON LINE.
D. CANCEL ALL SURGERIES FOR THAT MONTH

Section Seven: Clean/Sterile Storage

Estimated Contact Time: **45 minutes**

This module is designed to:

….help you understand the requirements for clean and sterile storage. It explains what clean/sterile storage is and how to maintain it; details the proper way to handle, store, and deliver medical supplies in order to keep clean items clean and sterile items sterile; and describes storage options for different types of supplies.

Following instruction, you should be able to perform the following:

- ☑ Identify the requirements for clean/sterile storage.
- ☑ Demonstrate proper material handling procedures.
- ☑ Select appropriate storage.

What is Clean/Sterile Storage?

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 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.

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SPD is responsible for storing and maintaining clean and sterile supplies throughout the medical center. This includes the case cart area and clean/sterile storage in SPD, and the supply closets, which are located on the wards. Most supplies are kept in the designated clean/sterile storage area within SPD. New supplies are received into the "breakout" area, where they are removed from their cardboard boxes or shipping containers and sorted and logged into the inventory system.

Ward closets or "secondaries" are storage areas where frequently used supplies are kept so that they are easily accessible for use by the medical personnel on the ward. They contain items like steri-strips, gauze, bedpans, and blood pressure monitors. SPD maintains the inventory based on an order and schedule that is coordinated with the unit.

The case cart area is a special part of the clean/sterile storage area where supplies for specific procedures are stored. The carts and containers, as well as the supplies, must be protected from contamination because they often are used in aseptic environments like operating rooms.

Maintaining Clean/Sterile Conditions

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 cleanliness and sterility of those items. Certain restrictive techniques and procedures 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.

Restrictions

Once items are received in the distribution area of SPD, it is essential that they be protected until they are needed for use.

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Certain restrictive guidelines have been established to help ensure that both sterile and clean supplies are kept under the best possible storage conditions for the safety and protection of both patients and employees.

The following activities are not permitted in SPD:

- use of tobacco products
- applying cosmetics
- eating
- drinking
- storing food items (including beverages)

Such items can spoil and draw flies or vermin, leading to the contamination of medical supplies.

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

Reporting Variations

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

Personal Attire

In order to protect the supplies from contamination that may be present on workers' clothing, only hospital issued clothing is to be worn in the Clean/Sterile Storage area. In the case cart storage area, scrub suits, long sleeves, and head and beard covers are required.

The SPD uniform, consisting of white pants and a blue smock, also makes it easy to identify authorized personnel. Access to the clean/sterile storage area is limited to those with official SPD business. If it is necessary for personnel to enter the

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sterile storage area wearing other clothing, they must don a cover gown or jacket.

While distributing supplies to other areas of the medical center, SPD personnel should wear the regular SPD uniform.

Environmental Cleaning

A regular schedule is set up with the Environmental Management Service for cleaning SPD. This includes daily wet mopping or vacuuming of all floors. SPD personnel are responsible for cleaning all work surfaces and sinks on a daily basis and other areas, such as storage shelves, *breakout rooms* (clean receiving), and equipment storage areas on a regularly scheduled basis. An approved disinfectant must be used.

When cleaning shelves or cabinets, you must be careful not to contaminate surrounding supplies. Remove all supplies on adjacent shelves and use caution when using disinfectant or cleaner.

Spray cleaners should not be used because of the danger of contamination.

Environmental Controls

In order to maintain sterility, environmental conditions in SPD must be carefully controlled.

Temperature	The room temperature in all SPD areas is to be kept between 65 degrees and 72 degrees Fahrenheit.
Humidity	Humidity levels should remain between 35 and 75 percent.
Air Exchanges	10 air exchanges per hour are required.

In addition to these requirements, the circulation of people, air, and work must be directed so that harmful microorganisms do not enter the clean/sterile area.

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Air Flow

Clean/sterile areas of SPD are maintained under positive air flow. This means that a greater amount of air is forced into a room than is exhausted. This forces the air to seep out through other avenues such as doors, service windows, and other cracks and crevices. This flow of air from clean to dirty lessens the chance that air-borne contamination will enter the clean/sterile area.

Doors must be kept closed to maintain positive pressure.

People flow

Traffic in SPD should be restricted to authorized personnel. Only those having official business in SPD should be allowed access, and they should be accompanied by an SPD supervisor or designee. This helps minimize the microorganisms that enter on people and their clothing. Traffic patterns must be designed so that people move from clean areas to dirty areas. If a task requires someone to move from a dirty are into a clean one, proper aseptic procedures must be followed.

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. Reusable devices that do not require sterilization go directly from decontamination to the clean/sterile storage area.
- 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.

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Proper Handling

Environmental controls are not the only factors that impact the medical supplies and equipment that SPD provides medical center clients. How a product is handled and stored can greatly affect its useability.

When supplies are received in the receiving or breakout area, the shipping containers must be examined for damage. If a box is torn, crushed, or stained, the contents should be examined for damage or contamination. Any questionable condition must be brought to the attention of the SPD Chief. Damaged products can often be returned to the manufacturer for credit or replacement.

Before any item is moved into the clean/sterile storage area, 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 must never be used as dispenser bins or storage containers. SPD personnel should wear a cover gown over their uniform while breaking out items from shipping containers. The dirty gown must be removed before returning to the clean/sterile storage area.

Clean/sterile items should be transported so that they are not bent or compressed. When delivering items, aseptic techniques should be followed. Items should not be carried under the arm or chin or in the teeth. Smaller items should be transported in a bag, larger items on solid bottomed carts that are closed or covered with an impervious cover.

All 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 because they promote contamination. Storage shelves should be organized so that supplies are easy to access. Avoid overcrowding.

Inventory Rotation

Stock rotation is important in reducing the number of outdated supplies and the costs associated with discarding and reprocessing medical supplies. The acronym “FIFO” or “First In, First Out” is used to describe the practice of rotating stock to ensure that older supplies are used up first, before newer items. Supplies on the shelf

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are pulled first from the top right, front and new supplies are stocked beginning on the left, back, and bottom. Once a week and prior to being issued, all sterile medical supplies must 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 be returned to SPD for reprocessing, if they are reusable. If they are disposable, they may be returned to the supplier for a credit.

Storage Systems

There are two basic types of storage systems. Most medical centers have a variety of styles of each type. Regardless of the type of shelving used, they must all be wiped down and cleaned with a hospital approved disinfectant on a regular basis.

Open Shelving

Open shelving usually consists of wire shelves with movable dividers that are used to separate products. Open shelving is the most common type of storage unit and offers the most efficient use of space. It also makes it easy to locate supplies. One disadvantage of open shelving is that the supplies are not protected from environmental hazards and supplies are more susceptible to unauthorized removal.

Closed Shelving

Closed shelving includes metal cabinets and portable lockers, such as exchange carts. In a closed system, there is limited air circulation, which lessens the opportunity for contamination. Unauthorized access may be discouraged since the contents are not visible. There are some drawbacks to closed systems. They may take up more space because they are bulkier, and additional

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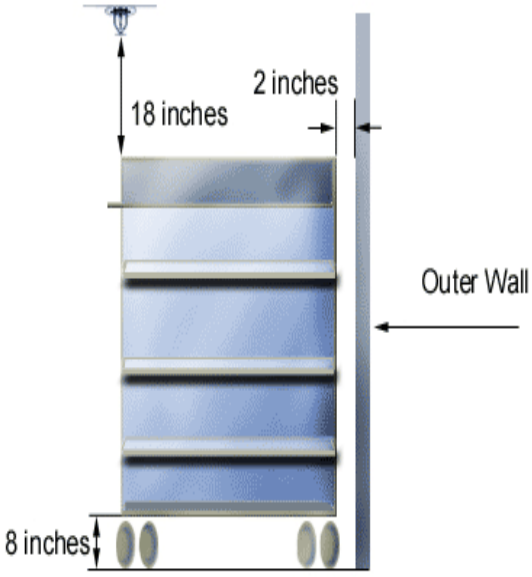
clearance is required for opening the doors. Opening and closing the doors quickly may catch supplies, causing damage. Doors should be opened slowly to avoid creating a rush of air (the "bellows" effect) which could force airborne microorganisms into the packaging. Since supplies are not visible, they may be harder to locate or access in a hurry.

All shelving must adhere to prescribed clearances from walls, floors, and ceilings (including lights and sprinklers).

- 2 inches should be maintained between sterile supplies and outer walls due to the possibility of condensation
- 18 inches between supplies and ceilings and ceiling fixtures to prevent interference with light and sprinkler operation
- At least 8 inches off the floor to prevent contamination from wet mopping



All shelving must have a solid bottom shelf to prevent dust, dirt, and water from being conveyed onto supplies located on the bottom shelf.

Space saver shelving is not recommended in any SPD area. It provides limited access for pulling or stocking supplies and may restrict access to supplies in an emergency.

Keeping Track of Stored Items

Periodically, inventories must be taken of the supplies that are stored in SPD. This helps to ensure that the right amount of each item is available and ready for use when needed for patient care. Module 9, Inventory Management, covers this process in detail.

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Supplies are ordered, maintained and dispensed using a computer system that allows accurate, real-time monitoring, automatic ordering, and efficient billing.

SPD technicians are responsible for accurately recording items taken in and distributed to users, rotating inventory to avoid outdates, and pulling any items that have reached the end of their shelf life.

Did you know?

There is no real distinction between sterile and clean storage areas; all medical supplies should be stored under the same conditions. This makes it easier to locate all like items in the same area, and ensures that all patient care supplies are equally protected from contamination.

Summary

The clean/sterile storage area of SPD is designed with environmental and procedural controls that aid efforts to maintain the sterility of all products. The setup of the clean/sterile storage area should allow supplies to be located and dispensed quickly and accurately. When patient care items are needed right away, precious time should not be wasted searching up and down aisles for the correct product.

The clean/sterile storage area must be:

- Secure from unauthorized access
- Separated from public or traffic areas
- Environmentally controlled in terms of temperature, humidity, and air exchange
- Large enough to provide adequate storage
- Organized to provide fast, efficient access to needed supplies

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✓ Check What You Know

1. Why is a Clean/Sterile Storage area necessary?

    a. To protect workers from the danger of cross contamination

    b. Because Pharmacy won't store the items

    c. To protect supplies from contamination until they are needed

    d. So non sterile supplies can be separated from sterile ones

2. How should outdated supplies be handled?

    a. Treat them as if they were contaminated
    b. Remove from storage and reprocess or return to supplier
    c. Move them to the front so they will be used up quickly
    d. Mark them with a permanent marker

3. Clean/sterile storage…

    a. ensures that adequate supplies are available on a 24-hour basis.

    b. contributes to overstocking and cost overruns.

    c. requires environmental and procedural controls.

    d. may inhibit timely access to critical supplies.

4. Which of the following contribute to maintaining the sterility of supplies and equipment?

    a. Temperature control
    b. Restricted access
    c. Food and drink prohibited
    d. Use of fans for adequate ventilation
    e. Limited air exchange
    f. Air flow under negative pressure
    g. Reporting insect infestations

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5. Which of the following is not prohibited in the clean/sterile storage area of SPD?
    a. Chewing gum or eating breath mints
    b. Carbonated beverages
    c. Wearing lipstick
    d. Candy bars or snacks

6. What is the proper personal attire for SPD personnel while distributing supplies to the wards?

_____

_____

7. What temperature should be maintained in SPD? _____

8. What humidity level is required in SPD? _____

9. Indicate the direction of flow in SPD.

a. People flow	clean-to-dirty	dirty-to-clean
b. Work flow	clean-to-dirty	dirty-to-clean
c. Air flow	clean-to-dirty	dirty-to-clean

10. How many air exchanges per hour are required in sterile processing and storage?

_____

_____

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11. Shipping containers and corrugated cardboard boxes should:

    a. Never be brought into SPD
    b. Can be used as dispenser bins if they are clean and in good condition
    c. Are not permitted in the sterile storage area
    d. May harbor microorganisms

12. Where would you place new supplies when stocking this shelf?

---

13. Place an "**O**" or a "**C**" next to each statement to indicate whether it describes **Open** or **Closed** shelving.

    – Most common
    – Restricted air flow
    – Easy to locate supplies
    – Supplies aren't protected
    – High pilferage rate
    – More secure
    – Bulky, may reduce available space
    – Possible supply damage from doors
    – Harder to locate what is needed

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Terminology

The following terms were used in this module.

air flow	The circulation of air particles within a confined space (such as the SPD department)
breakout room	An area established for unloading and unpacking medical supplies (also known as Receiving)
disinfectant	Chemical agents used in cleaning that inhibit/destroy the growth of pathogenic microorganisms. They may have little or no effect on bacterial spores
infestation	The presence or inhabitance of an area by a large number of organisms (in this case vermin or pests)
inventory loss	Supplies that are unusable (and represent an unrecoverable cost) due to damage, outdating, or theft
outdates	Supplies whose “use by” date has expired
people flow	The movement of individuals in the course of doing their assigned tasks
scrubs	A set of solid-color, loose-fitting cotton clothing worn by hospital personnel (the name comes from the fact that doctors don them prior to scrubbing for a procedure)
work flow	The movement of supplies as they are processed in SPD (from dirty to clean)

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Module 7 - CLEAN/STERILE STORAGE

1. STERILE STORAGE IS?
A. WHERE STERILE SUPPLIES AND INSTRUMENT SETS ARE STORED AND ARE MADE AVAILABLE WHILE PROTECTING THEM FROM CONTAMINATION.
B. WHERE DIRTY INSTRUMENTS CAN BE CLEANED
C. WHERE YOUR CLEANING SUPPLIES ARE STORED
D. WHERE STERILE SUPPLIES ARE KEPT INDEFINITELY.

2. THE AIR EXCHANGES IN CLEAN/STERILE STORAGE SHOULD BE?

A. < THAN 6 PER HOUR
B. NOT MONITORED
C. 10 PER HOUR
D. THE SAME AS THE DIRTY ARES OF SPD

3. THE HUMIDITY INSIDE OF CLEAN/STERILE STORAGE AREA'S SHOULD BE?

A. 80-100%
B. 0-30%
C. NOT MONITORED
D. 35-75%

4. WORK FLOW WITHIN SPD IS AS FOLLOWS?

A. DECON-STERILE STORAGE-PREP
B. DECON-PREP-STERILE STORAGE
C. STERILE STORAGE-DECON-PREP
D. PREP-DECON-STERILE STORAGE

5. THE PROPER STOCK ROTATION IN STERILE STORAGE IS?

A. LAST IN LAST OUT
B. LAST IN FIRST OUT
C. FIRST IN FIRST OUT
D. FIRST IN LAST OUT

6. WHEN USING A CLOSED SHELVING SYSTEM IN STORAGE THE TECH SHOULD BE CAREFUL IN OPENING AND CLOSING THE DRAWERS TO FAST CAUSING MICROORGANISMS BEING FORCED INTO STERILE PACKAGING IN AN EFFECT KNOWN AS?

A. WIND SWEEPING
B. BELLOWS
C. WIND TUNNEL
D. WIND WALKING

7. THE SHELVING CLEARANCE INSIDE OF STERILE STORAGE BETWEEN SHELVES AND THE CEILING IS?

A. 2"
B. 18"
C. 8"
D. 24"

8. THE CLEARANCE INSIDE OF STERILE STORAGE BETWEEN THE SHELVING AND THE FLOOR IS?

A. 2"
B. 18"
C 8"
D 24"

9. CHECKS FOR OUTDATED ITEMS INSIDE OF STERILE STORAGE SHOULD BE DONE?

A. ANNUALLY
B. BI-WEEKLY
C. WEEKLY
D. MONTHLY

10. TRUE OR FALSE CORRUGATED BOXES ARE BOXES THAT ARE PRESSED AND HAVE SPACE VISIBLE BETWEEN SECTIONS OF MATERIAL.

TRUE - FALSE

11. SHIPPING BOXES AND CORRUGATED BOXES SHOULD?

A. NEVER BE BROUGHT INTO ANY AREA'S WITHIN SPD
B. BE OPENED IN THE PREP AREA
C. BE OPENED IN DECONTAMINATION
D. NONE OF THE ABOVE

12. WHICH OF THE FOLLOWING IS *NOT* RESTRICTED INSIDE OF STERILE STORAGE?

A. FOOD
B. DRINK
C. FOOTWEAR
D. LIPSTICK

13. STERILE STORAGE ENVIRONMENTAL CONTROL CALLS FOR?

A. DRY HOT ENVIRONMENT
B. NEGATIVE PRESSURE
C. POSITIVE PRESSURE
D. COLD WET ENVIRONMENT

14. THREE TYPES OF STERILE STORAGE ARE?

A. PRIMARIES, WARDS, WAREHOUSE
B. DECON, WAREHOUSE, CASE CART AREA
C. CASE CART AREA'S, PRIMARIES, SECONDARIES
D. NONE OF THE ABOVE

15. THE UNIFORM REQUIRED TO BE WORN IN STERILE STORAGE IS?

A. SCRUBS, HEAD COVERS, GLOVES, SHOE COVERS
B. ANYTHING THE EMPLOYEE WANTS TO WEAR
C. LAB COAT, JEANS AND SCRUB TOP
D. WHITE PANTS, BLUE TOP AND DEDICATED SHOES

16. WHICH OF THE FOLLOWING ARE THRU PROPER METHODS FOR CARRYING ITEMS FROM SPD TO SECONDARIES?

A. UNDER YOU ARM
B. IN A PLASTIC BAG
C. IN A COVERED SECURE CART
D. PASSED FROM ONE PERSON TO THE NEXT
E. B & C

17. THE SHELVING SYSTEMS USED INSIDE OF STERILE STORAGE SHOULD BE CLEANED AT LEAST?

A. DAILEY
B. WEEKLY
C. MONTHLY
D. YEARLY

18. STERILE STORAGE SHOULD BE?

A. SEPARATED FROM PUBLIC ACCESS AREA'S
B. ORGANIZED
C. CLEANED DAILEY
D. ENVIRONMENTALLY CONTROLLED
E. ALL OF THE ABOVE

19. SPD TECHNICIANS ARE RESPONSIBLE FOR ALL OF THE FOLLOWING *EXCEPT*?

A. WASHING THE FLOORS DAILY
B. WASHING SINKS AND WORK SURFACES DAILY
C. STOCK ROTATION
D. PULLING OUTDATES

20. STERILE STORAGE OF SPD SHOULD BE ALL OF THE FOLLOWING *EXCEPT?*

A. NEAT, CLEAN ORDERLY
B. LOCKED AT ALL TIMES
C. ACCESSIBLE TO ALL EMPLOYEES OF THE MEDICAL CENTER
D. HAVE 10 AIR EXCHANGES PER HOUR

Section Eight: Distribution

Estimated Contact Time: **45 minutes**

This module covers:

…d*istribution,* the process of providing medical supply items to the user wards, clinic units, and operating room suites. Accurate, efficient, distribution of equipment and supplies is critical to providing quality patient care. If the correct supplies don't reach their intended user in a useable condition, then the decontamination, sterilization, and storage processes are just a waste of time.

Following instruction, you should be able to perform the following:

- ☑ Identify distribution and delivery methods and procedures, including:
  - five main distribution types
  - types of specialty carts and their use
  - delivery methods and equipment
  - delivery procedures and equipment tracking

Distributing Supplies

The distribution area is the center of the Supply, Processing and Distribution organization. Its purpose is to stock, maintain, and distribute sterile and clean medical supplies and equipment to the user areas for patient care needs. Items are usually distributed to the ward and clinic areas according to a prearranged schedule and to operating rooms on a daily basis, depending on the procedures that are scheduled.

SPD technicians must be familiar with the names and uses of supplies and equipment, and be able to deliver them, where they are needed, when they are needed.

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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 distribution is requirement driven. The number and type of supplies, who needs them, when, and where, are all factors which determine the type and method of distribution. It is important for you to understand the characteristics and advantages of each type and the reasons for its use in your medical center.

SPD uses five main distribution methods to ensure the right product is delivered, in the right condition, at the right time.

- Par level
- Demand
- Exchange cart
- Case cart
- Specialty carts

Par Level Distribution

For most healthcare facilities the par-level system is an excellent means of managing user needs while controlling inventory. It is the most commonly used system and should be considered for all common use items. In a "par level" system, the SPD technician conducts routine inventories of supply closets, treatment rooms, and nurse-servers to determine what has been used. Supplies are replenished based on a pre-established or "par" level which has been set through communication with the end user. Par levels must be reviewed frequently and changed, if necessary, to reflect actual usage.

The SPD Technician is responsible for reviewing the stock levels and communicating with end users if changes are required.

A typical procedure for maintaining par level inventories is to assign a technician to each area or department. The technician inventories supplies in the treatment rooms, supply closets, and other storage areas using a bar code scanner and generates a list of the needed supplies. S/he then returns to the SPD department, fills the order and delivers the supplies to the user areas, restocking items to the agreed upon level. In healthcare facilities that use nurse-servers for storing patient care supplies, a pre-stocked mobile

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cart may be used to restock the servers to par level. A list of all required items and levels is posted on the door. The SPD technician uses supplies from the cart to replenish the nurse servers on a scheduled basis. The SPD technician is responsible for keeping the cart stocked with all necessary supplies.

Demand Distribution

In demand distribution, the user area staff is responsible for maintaining adequate supply levels. They determine their needs, and request items from SPD. This can be done in person, by phone, or online. An SPD employee pulls the requested items from inventory and delivers them to the user area, where the requester is responsible for their storage and use. "On demand" requests can be made on a regularly scheduled basis or as the need arises—hence the name "demand". While most healthcare facilities have used some form of the demand system at one time or another, it is not the most efficient method and relies heavily on the end users having the time to closely manage inventory. End users are often comfortable with this method because it is easy to use and they are familiar with it, but it takes away from the time they have to devote to patient care. It is the method of choice for rare or seldom used items.

Exchange Cart Distribution

The exchange cart system is also based on preset supply levels. Supplies are placed in a cart that is stored in the user area. An identical cart is stocked and maintained in the SPD area. On a regular basis, the SPD technician exchanges the stocked cart from the SPD area for the one in the user area, ensuring that adequate supplies are always on hand. Exchange carts are the method-of-choice for high inventory turnover areas such as O.R.s and ICUs. While the system is

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convenient and easy to manage, there are additional costs associated with creating and maintaining duplicate carts.

Case Cart Distribution

In the case cart system, a cart is stocked with all the supplies needed for a specific surgical procedure or case. At the completion of the surgery, all contaminated reusable devices are placed in the cart. The cart is retrieved by SPD personnel and taken to the decontamination area for reprocessing. This enhances infection control by minimizing the chance of cross contamination.

The supplies and instruments for the case cart system may be provided by different methods, such as procedure cards, requisition forms, or computer printouts. With the computer assisted approach, each surgery is assigned a case number. Based on the surgery schedule for the day, an SPD computer operator generates a supply list for each case. An SPD technician pulls the required supplies and places them in a case cart. The stocked case cart is delivered to the operating room prior to the scheduled surgery time.

Specialty Cart Distribution

Specialty carts are carts that contain supplies needed in emergency or special situations. They must be solid or impervious covered and have a solid bottom shelf. After a specialty cart has been used, it must be returned to the receiving area and unused supplies removed, prior to taking the cart into the decontamination area for cleaning.

They include:

- ***Disaster carts,*** which are stocked with medical supplies needed for use in a sudden community misfortune, such as a large traffic accident, bombing, or flood. This requires a cart that can be easily transported to the scene of the disaster, whether it is internal to the medical center or outside in the community (external).

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- ***Implant carts,*** which are carts stocked with implants, such as intraocular lens, vascular grafts, and knee and hip prostheses that are transported to the operating room at the time of the specific surgery.
- ***Crash/Code carts,*** which are specialty carts that are used in emergency situations to revive victims from respiratory failure or cardiac arrest. SPD stocks the medical supplies and the pharmacy stocks the drugs and intravenous solutions. Crash carts are kept throughout the medical facility in order to be available when needed and they must be locked with a tamper proof lock. A list of all supplies and drug expiration dates must be posted on the outside of the cart. These carts should be inspected daily to ensure the security of the cart and exterior supplies and equipment.
- ***Special procedure carts,*** as the name implies, are carts that contain supplies and equipment required for performing specific procedures. They include arterial line carts, central line carts, Swanz Ganz carts, urology carts, and suture carts. Specialty carts provide a means to be immediately responsive in time-critical situations. Keeping track of the carts, their locations, and contents requires diligence.

SPD employees should read the policy and procedures manual at their medical centers to know their role and what is expected of them during an emergency situation.

The efficient distribution system:

- Provides information on future supply needs
- Makes supplies available to the user in a timely, accurate manner
- Provides for control and documentation of inventory

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Distribution Type:	Advantages	Disadvantages
Demand	• Simple • Easy-to-use • Familiar	• Labor intensive • Not suitable for high volume distribution • May be low priority for personnel in patient care areas • Expensive because it encourages hoarding
Par Level	• User friendly, saves nurses time • Ensures optimum inventory levels	• Distribution can be time-consuming • Heavy use may require the technician to make multiple trips to SPD • In large facilities, timeliness of restocking can be an issue
Exchange Cart	• Facilitates control and documentation of stock • Practical and easy-to-manage • Cost effective in terms of inventory levels, time, and manpower	• Requires duplication of stock • Requires additional storage space • Initial start-up costs can be high
Case Cart	• Relieves nurses of supply duties, allowing focus on patient care • Allows efficient processing and management of equipment • Provides enhanced infection control • Ensures better inventory control	• Requires additional expense and storage for carts • Efficiency is affected by SPD proximity to O.R. • May require more stringent dress and traffic control
Specialty Carts	• Allows quick and easy access • Ensures that required supplies are available in time-critical situations • Allows supplies to be readily available at point-of-use	• Requires additional labor to ensure that expiration dates are checked routinely • Requires coordination with Pharmacy • Requires constant monitoring to ensure cart hasn't been opened

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Delivery Methods and Equipment

SPD uses a variety of methods to transport supplies from one area to another.

- ***Distribution carts*** are closed or imperviously covered carts that are used to transport supplies. They should be sturdy, maneuverable, easy to roll, and closed to protect the supplies.
- ***Dumbwaiters*** and other mechanical devices are used to transport small quantities of supplies upon request.

CAUTION!

Pneumatic tubes should not be used as dumbwaiters. They operate using a vacuum and are intended only for paperwork. Placing supplies in them can compromise the packaging or lead to contamination.

- In emergency situations, SPD personnel may be requested to deliver items "***stat,***" meaning immediately. "***Stat" supplies*** should be hand delivered as soon as possible after receiving the request. Supplies must be protected during transport. Because of the possibility of a power failure, mechanical devices cannot ensure that "stat" items reach their destination within acceptable time limits.
- ***Window pickup***—In some healthcare facilities, users can obtain items directly from SPD by coming to a designated pickup point in the department. This method of distribution is not recommended because it requires full time manning and pulls resources from other tasking, and because the user should not have to come get supplies. If it is necessary to provide this distribution option, a designated pickup location is required in order to minimize traffic in the SPD area. Technicians must log all supplies that are distributed through this method.

All distribution methods must be cleaned with a germicidal solution on a regular basis; this includes conveyors, storage areas, and transport vehicles or carts.

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If an item is not delivered, in the right condition, at the right time, patient care can be affected. Careful handling and timely delivery also ensure that end users rely on SPD as an integral part of the healthcare team. This discourages hoarding and helps to contain costs.

The Distribution Process

Each step in the distribution process must be performed with accuracy and efficiency. There is no margin of error where patient health is concerned.

Selecting Items from Inventory

Distribution begins with a request for supplies or equipment. Generally the request is a computer generated list, but it can also be by phone or in person. It is your responsibility to inspect each item as it is pulled from inventory and to avoid delivering unusable items to user areas. Selecting the right item is just the beginning. For every supply request you should:

- Handle items carefully to avoid damaging or contaminating them.
- Verify the type and quantity before transporting to the point of use.
- On sterile items processed by SPD, check the **expiration date**, **external chemical indicator** (to verify the item was subjected to the sterilization process), and the packaging (to be sure it is not damaged, wet, or soiled).
- On commercially prepared sterile items inspect the expiration date and the packaging.

When pulling supplies from storage to fill a user request, you should always follow the FIFO principle. FIFO stands for First In, First Out and describes the practice of rotating stock by placing new items on the left, back bottom and pulling items for use from the right, top, front. This ensures that no single item remains on the shelf for too long, and that the items with the closest expiration dates get used first.

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Delivering Items to Users

While supplies are being transported, the SPD technician is responsible for ensuring that they have the same protection that they are provided while stored in SPD. They must be covered with impervious material or enclosed to protect them from environmental hazards. If a cart is used to transport supplies, it must have a barrier or solid bottom shelf to protect the supplies from the wheels and floor. Clean/sterile supplies must never be transported on the same carts or in the same containers as contaminated supplies. If an item is dropped or falls on the floor, it must be inspected to see if it is damaged or compromised. If damaged it must be returned to SPD and reprocessed or discarded.

Right item to the Right user, in the Right place, at the Right time, Ready for use.

Be careful when delivering supplies to other areas of the medical center. Never leave distribution carts unattended. This can cause patient/employee injury, loss, or theft of supplies, and contamination of sterile supplies.

Tracking Medical Equipment

Each 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 must be tracked in order to know where it is being used and to ensure that all required safety inspections and preventative maintenance have been performed.

NEVER deliver equipment to the point of use if it has not been inspected and determined to be functioning properly.

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Summary

To users, the distribution area is possibly the most visible part of SPD. 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.
There are five main types of distribution systems:

- Par level
- Demand
- Exchange cart
- Case cart
- Specialty carts

The services the healthcare facility provides, its size, physical design, age, resources, and mission will all influence the distribution methods and process.

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✓ Check What You Know

1. Match the following carts to their descriptions.

Implant	Used in emergency situations to revive victims from respiratory failure or cardiac arrest
Crash	Must be transported to the operating room when implant surgery is scheduled
Disaster	Stocked to deal with emergency misfortunes
Exchange	Provides the operating room with selected supplies for a specific surgery
Case	Requires two identical carts; one in SPD, one in user area

2. Match each term to the correct statement.

a. Par level	User is responsible for maintaining adequate supply levels
b. Demand	Supplies are restocked based on predetermined levels
c. Case cart	Supplies are replenished by swapping a used cart for a fully stocked one
d. Specialty Cart	Must be coordinated with the surgery schedule
e. Exchange cart	Stocked with supplies required for a specific emergency situation

3. Match each type of cart with its description.

Case cart	Allows optimum inventory levels
Demand	Simple and familiar, though labor intensive
Specialty Cart	Provides enhanced infection control
Par level	Ensures timeliness of supplies during emergency situations
Exchange cart	Minimizes inventory time, allows for thorough documentation, and control of patient care supplies

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4. A surgical nurse calls and tells you that the long biopsy forceps being used in O.R. 3 have been dropped and she needs another one, STAT. What do you do?
    a. Drop what you are doing and hand deliver another one to O.R. 3 immediately
    b. Tell her to swipe one out of the cart in O.R. 2 and you will replace it
    c. Tell her to flash sterilize it
    d. Make a note to include two biopsy forceps in future trays

5. You receive a directive that describes a new, economical brand of tubing that the medical center will begin using. This tubing is stored in all secondaries and many nurse servers. What should you do?
    a. Search the breakout room for the shipment of tubing, and hand carry a supply to each ward, discarding the old brand
    b. Include the new tubing in all future exchange carts
    c. Wait until your supervisor tells you what to do
    d. Continue to use the current brand until the supply runs out
    e. Notify the end users that the tubing will be changing

6. When delivering supplies to patient care areas:
    a. Use open carts to speed delivery process
    b. Use proper body mechanics to avoid injury
    c. Insist that users sign for all items
    d. Leave carts in the hall to avoid interrupting the workflow in congested areas

7. What should you do when pulling sterile supplies from stock to fill a user request?
    a. Verify the type and quantity of item requested
    b. Check the package expiration date
    c. Examine the item to ensure that it is sterile
    d. Examine the indicator to ensure that the package has been sterilized
    e. Pull the item from the top, back left stock position

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8. Which of the following are acceptable delivery methods for clean and sterile supplies?
    a. Dumbwaiter
    b. In person for STAT items
    c. Patient pickup
    d. Distribution cart
    e. Pneumatic tubes

9. Which of the following statements are true regarding SPD supply delivery methods?
    a. STAT deliveries must be scheduled on a regular basis
    b. Pneumatic tubes and dumbwaiters must be used only for prescheduled deliveries
    c. Distribution carts should not be used for contaminated item pickup
    d. All supplies distributed through a "pickup" window must be logged

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Terminology

The following terms were used in this module.

Case Cart System	a distribution system that requires SPD to assemble a cart of supplies based on the surgical procedure to be performed and deliver it to the operating room prior to the scheduled procedure, this system must be closely coordinated with the surgical schedule
Demand System	(Requisition and Delivery Distribution)—a distribution system that requires end users to inventory supplies, determine their need, and request replenishment from SPD (users ask for things when they need them)
diligence	meticulous care or attention
distribution area	the section of SPD where supplies are stored prior to being used; this includes the case cart area, clean/sterile storage and bulk storage
Exchange Cart System	a distribution system that involves stocking two identical supply carts with the items a user requires, one cart is kept in the user area and the other is kept stocked in SPD, replenishment is accomplished by exchanging the used cart for the fully stocked one
hoarding	keeping more than the required amounts of an item on hand, in order to avoid running out of it
Par Level Restocking	a distribution system that relies on preestablished stock levels, SPD inventories items on hand and replenishes them to the designated level
proximity	the closeness or nearness of one thing to another
Specialty Carts	a distribution system that requires SPD to assemble carts of supplies dedicated to a specific purpose (disaster, code, specialty procedure, etc.)

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Module 8 - DISTRIBUTION

1. TRUE/FALSE NURSING IS SOLELY RESPONSIBLE FOR SETTING/EVALUATING STOCK LEVELS?

TRUE - FALSE

2. AN EXAMPLE OF A DEMAND DISTRIBUTION SYSTEM?

A. TELEPHONE CALL FOR SELDOM USED ITEMS
B. CASE CARTS
C. EXCHANGE CARTS
D. POINT OF USE EQUIPMENT

3. A DISADVANTAGE OF THE EXCHANGE CART SYSTEMS IS?

A. THERE IS NO DISADVANTAGE
B. DANGER OF EMPLOYEE INJURY
C. COST OF MAINTAINING DUPLICATE CARTS
D. IT IS A DEMAND DISTRIBUTION SYSTEM

4. ALL OF THE FOLLOWING ARE EXAMPLES OF SPECIALTY CARTS *EXCEPT?*

A. CRASH/CARTS
B. ISOLATION CARTS
C. EXCHANGE CARTS
D. GU CARTS
E. DISASTER CARTS

5. TRUE/FALSE ANY STAFF MEMBER CAN BRING A DIFFERENT ITEM FOR USE IN THE FACULTY WITHOUT PRE APPROVAL.

TRUE - FALSE

6. THE ADVANTAGES OF A CASE CART SYSTEM ARE?

A. PROVIDES EXCHANGE INFECTION CONTROL
B. ENSURES INVENTORY CONTROL
C. RELIEVES USER SUPPLY DUTIES
D. ALL OF THE ABOVE

7. STEPS USED WHEN SELECTING ITEMS FOR DISTRIBUTION ARE?

A. HANDLE ITEMS CAREFULLY
B. ENSURE ITEM BEING PICKED IS THE ONE ORDERED
C. CHECK EXPIRATION DATE OF ITEM
D. ALL OF THE ABOVE

8. WHEN A NEW ITEM ARRIVES FOR STOCKING IT SHOULD PUT?

A. FRONT, TOP, RIGHT
B. FRONT, BOTTOM, RIGHT
C. BACK, TOP, LEFT
D. BACK, BOTTOM, LEFT

9. THE FIVE *R'S* OF DISTRIBUTION ARE ALL OF THE FOLLOWING *EXCEPT?*

A. RIGHT ITEM
B. RIGHT USER
C. RIGHT SIDE
D. RIGHT TIME
E. RIGHT PLACE

10. IF AN ITEM FALLS ON THE FLOOR WHAT DOES THE SPD TECH DO?

A. INSPECT IT FOR DAMAGE
B. NOTHING
C. USE THE 30 SECOND RULE
D. SEE IF YOU ARE ALONE AND THEN DECIDE

11. PRIOR TO TAKING EQUIPMENT TO A USER THE TECH SHOULD?

A. NOTHING IT SHOULD ALREADY BE READY FOR USE
B. CHECK TO MAKE SURE THAT ALL SAFETY/PREVENTIVE MAINTAINCE INSPECTIONS ARE STILL CURRENT
C. SPD DOESN'T DELIVER EQUIPMENT
D. A & C

12. A CRASH CART IS A SPECIALTY CART USED FOR WHAT?

A. PATIENTS WITH COMMUNICABLE DISEASES
B. PATIENTS HAVING A SPECIAL PROCEDURE
C. USED IN EMERGENCY SITUATIONS TO REVIVE VICTIMS FROM LIFE TREATING PROBLEMS.
D. USED WHEN A PATIENT NEEDS A URINARY CATHETER

13. A PAR LEVEL DISTRIBUTION SYSTEM IS?

A. USER IS RESPONSIBLE TO KEEP TRACK OF THEIR SUPPLIES
B. STOCKED ONLY ON AN EMERGENCY BASIS
C. SUPPLIES ARE STOCKED ACCORDING TO PREDETERMINED LEVELS
D. NONE OF THE ABOVE

14. OF THE FOLLOWING WHICH IS *NOT* AN ACCEPTABLE DELIVERY SYSTEM FOR ITEMS FROM SPD TO USER'S?

A. DUMBWAITERS
B. IN PERSON
C. DISTRIBUTION CART
D. PNEUMATIC TUBE

15. IF SPD DOES NOT PROVIDE ADEQUATE SUPPLIES, USERS MAY?

A. COMPLAIN TO SUPERVISORS
B. HOARD SUPPLIES
C. LOSS TRUST IN SPD DELIVERS
D. ALL OF THE ABOVE

16. WHEN USING A DELIVERY CART TO DELIVER SUPPLIES TO PATIENT CARE AREAS THE TECH SHOULD?

A. USE OPEN CARTS FOR FASTER DISTRIBUTION ON THE FLOORS
B. USE PROPER BODY MECHANICS TO AVOID INJURY
C. MAKE USERS SIGN FOR SUPPLIES BEING DELIVERED
D. LEAVE DELIVERY CART AND TAKE A SMOKE BREAK

17. WHEN USING A DELIVERY CART THE TECH SHOULD?

A. PULL THE CART
B. PUSH THE CART
C. AVOID USING CONNER MIRRORS TO SEE IF ANOTHER PERSON IS COMING
D. MAKE SURE THE BOTTOM OF THE CART IS MADE OF A SCREEN TYPE MATERIAL

18. WHICH OF THE FOLLOWING STATEMENTS ARE TRUE?

A. STAT DELIVERIES SHOULD BE SCHEDULED ON A REGULAR BASIS
B. PNEUMATIC TUBES AND DUMBWAITERS CAN BE USED FOR PRESCHEDULED DELIVERIES
C. DISTRIBUTION CARTS SHOULD NOT BE USED TO PICK UP CONTAMINATED ITEMS.
D. SUPPLIES DISTRIBUTED THROUGH PICKUP WINDOWS DO NOT NEED TO BE LOGGED.

19. WHEN UTILIZING A PICK UP WINDOW SYSTEM?

A. BE SURE TO DOCUMENT ALL ITEMS DISPENSED AND AREA THEY WERE DISPENSED TOO.
B. ANYONE CAN COME AND GET ANYTHING THEY WANT
C. PICK UP WINDOWS ARE A WASTE OF TIME
D. NONE OF THE ABOVE

20. IN THE PAR LEVEL DISTRIBUTION SYSTEM?

A. THE TECH COMMUNICATES WITH THE USER SUGGESTING CHANGES IN THE LEVELS
B. ROUTINE INVENTORIES ARE CONDUCTED
C. LEVELS ARE PERIODICALLY CHECKED AFTER BEING SET IN PLACE.
D. ALL OF THE ABOVE

Section Nine: Inventory Management

Estimated Contact Time:
45-60 minutes

This module covers:

…the processes required to track, monitor, and maintain adequate numbers of supplies and equipment. Inventory Management is the framework that supports all the other SPD tasks and ensures that medical devices are available, on demand, when users require them. Maintaining accurate, timely inventory control is critical to keeping SPD efficient and cost effective.

Following instruction, you should be able to perform the following:

- ☑ Identify the role of inventory management.
- ☑ Identify purpose and contents of inventory reports.
- ☑ Detail the inventory process.
- ☑ Identify the various approaches to maintaining adequate inventory.

The Key to Cost Control

VA Directive Handbook 7176 defines Inventory Management as the process by which the right product is delivered at the right time, in the right condition, and ready for use, using resources in the most efficient manner and in accordance with established, sound inventory management practices.

The goal of good inventory management is to ensure that all users have what they need, when they need it. The key to doing this cost effectively is to purchase in large enough quantities to receive premium pricing from the vendor without tying up funds with overstocked shelves or retaining unneeded items until they reach their expiration date. SPD contributes to the medical center cost control effort through waste reduction, product standardization, and competitive procurement sourcing.

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Inventory management is the responsibility of each SPD employee. You are responsible for accurately recording every item that comes into and is distributed from SPD. Although computerized tracking systems can reduce the time and effort required to manage supplies, they are only as good as the data that is entered into them.

Types of Inventory

Traditionally, there have been two main types of inventory; primary and secondary.

- The **primary** inventory consists of all the supplies stored within the SPD area.
- The **secondary** inventory, or secondaries, is made up of stores of supplies that are kept at the point of use. These include ward closets and nurse servers.

In recent years, with the emphasis on cost containment, alternative inventory systems are becoming available that help control expenditures and reduce the amount of stock medical centers must keep on hand.

- In a **consignment** arrangement, a vendor maintains a portion of the primary inventory on the shelves and periodically bills the medical center for items used. Consignment is considered a "no cost" inventory program because the medical center pays nothing until items are used. In addition, the vendor may purchase the existing inventory on hand, generating a one time revenue boost.
- Another arrangement allows a single or **prime vendor** to serve as the distributor for a portion of the SPD primary inventory, regardless of brand or manufacturer. The vendor provides scheduled delivery, which allows SPD to greatly reduce the amount of stock on hand.
- A **Just-in-Time (JIT)** system reduces the primary inventory and provides stock for secondaries on a regular basis, ordering and providing the supplies “just-in-time.” This system works best when needs can be easily and accurately forecast. SPD conducts an inventory and submits an order to

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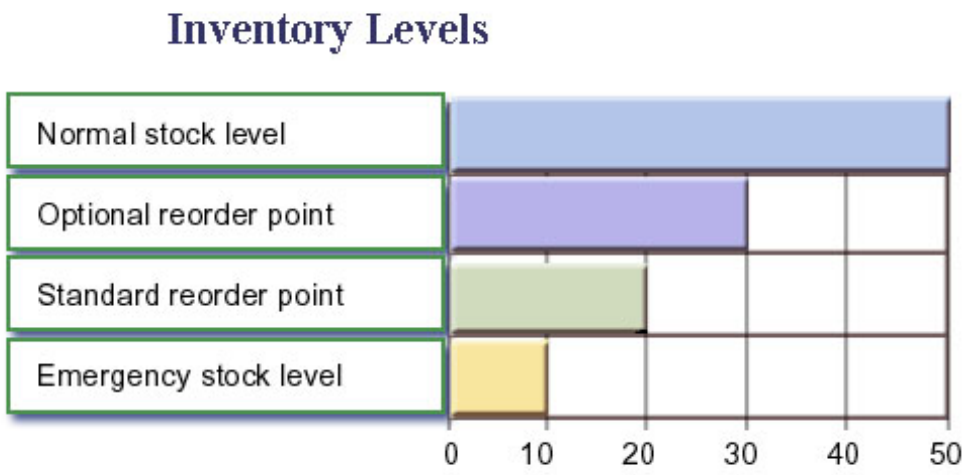
the vendor, receives and unpacks the supplies when they arrive, and delivers them to the secondary.

- In a **stockless** system, there is no primary inventory. Stock is delivered, prepackaged, to user areas by vendors, 2-3 times per day, 7 days a week. This system is dependant on reliable vendors with efficient distribution systems and is not recommended as the main inventory method.

Inventory Levels

SPD must maintain the appropriate stock levels in each area. There are four levels which must be determined for each item in the primary inventory.



- **Normal Stock**—The normal level represents the largest amount of an item that is to be maintained on SPD shelves.
- **Standard Reorder**—The level at which the item must be reordered. This is calculated by tracking daily use and factoring in the amount of time required to obtain replacement stock.
- **Optional Reorder**—This set-point alerts SPD that the level of an item has fallen below the normal stock level but has not yet reached the standard reorder point level. It allows SPD to consolidate orders for a specific vendor to reduce shipping charges and consolidate unpacking efforts.

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- **Emergency Stock**—This is the smallest acceptable amount of an item to be maintained in the primary. This level serves as an alert that the item could be depleted in the near future. An emergency purchase is required in order to avoid having an item become "out -of-stock".

In secondary inventories, only two levels are used; normal level and reorder level. Because secondaries must be kept stocked to meet users expectations, the normal and reorder level will be the same.

Controlling Inventory

Remember, SPD's goal is to have enough supplies available for users when they request them, without incurring unnecessary costs by maintaining excess stock or allowing items to reach their expiration dates. Overstocking an item can ensure that you never run out, however, it 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 having supplies unavailable and negatively impacting the quality of patient care. It can also generate additional purchase costs in the form of rush shipping. Most important, understocking can affect the trust users have in SPD.

As an SPD employee, you are the front line in controlling costs while meeting user expectations. The type of item, its cost, the user requirements, and frequency of use all factor into how you manage inventory. How often you order, distribute, and inventory supplies is driven by the user needs. While every effort should be made to have all items available at all times, (a 100% fill rate) a more realistic goal is to make sure critical items are available at all times, while less critical items may be on "back-order."

Monitoring Usage

Most medical centers use a computerized system to maintain stock levels and set reorder points. These systems are capable or

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tracking vast amounts of data and sorting it into useful output reports. These include:

- ***History of Distribution***, which shows the total dollar amounts of supplies distributed to each secondary.
- ***Inactive Item Report***, which identifies items that have not been used or requested for a given period of time.
- ***Cold/Hot Usage Report***, which tracks changes in the usage of a specific item. This allows SPD to adjust ordering up or down to keep up with user demand.
- ***Emergency Stock Level Report***, which flags items that may be in danger of being out-of-stock. This report also tells SPD if the item is currently on order.

Point-of-Use

At some medical centers, automation technology is being used to control supply distribution. Point-of-Use equipment provides controlled access to storage areas. Users enter their code to access supplies and record what they use. The equipment, which is electronically connected to the automated supply tracking system, keeps track of who uses what and generates a "pull list' which technicians use to restock the point-of-use stores. For ordering and budget purposes, it must also be connected to the computerized logistics and financial system.

Eliminating Waste

An item's shelf life is the time it is expected to remain safe for use. Remember that sterility is event related rather than time related. Contamination doesn't suddenly occur on the last day of the labeled shelf life. Factors such as improper handling, inadequate cooling time after sterilization, excessive stacking of items, exposure to extreme climate conditions, the type of material used, and how well the package is sealed, all impact the sterility of an item. Package integrity should always be examined before using an item and you must follow these guidelines for items with a low turnover rate.

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In addition to shelf life constraints, any SPD processed and packaged item that remains unused on the shelf for 6 months must be evaluated to determine if there is still a need for it and if the number being held in inventory is appropriate. If the item is still needed, its location should be evaluated to ensure it is accessible. Medical center processed items should not remain on the shelf for more than a year. They should be reevaluated to determine if they are still needed. If they are to continue to be stocked, they must be reprocessed.

Guidelines for Shelf Life

Item	Store for:
Woven and non-woven wrapped items with no dust cover	30 days
Woven and non-woven wrapped items with a dust cover	1 year
Paper/plastic peel pouch	1 year
Containerized systems	1 year
Commercially packaged items	Manufacturer Recommendations

Standardization

One practical method of reducing medical center costs is to standardize the supplies that are used. This simplifies inventory ordering and storage and allows the medical center to take advantage of volume discounts. The Commodity Standardization Committee and related subcommittees review and evaluate products for use in the medical center. Their goal is to reduce the number, sizes, kinds, and grades of items while maintaining quality, state-of-the-art medical service.

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Recalls

Occasionally you may have to locate and remove items from stock as part of a recall. The type of recall will dictate what you do with the items. Items may be recalled due to a positive biological test, manufacturer instructions, or FDA direction.

- **Biological test**
  If one of the biological tests on a sterilizer cultures positive (there is evidence of microscopic life) or a control is negative (there is no microorganic growth), you must pull everything that was sterilized after the last good test. Physically retrieve the items from storage and have them reprocessed. If items have already been used, you must notify the user of the bad biological test.
- **Manufacturer's recall**
  If a manufacturer has determined that there are problems with a specific product, they may voluntarily recall the product. They will issue a recall which includes instructions regarding what to do with the product and how to get credit for it. Every hospital has a recall manager who is responsible for monitoring recall processes.
- **FDA recall**
  In the rare instance where there is a potential for serious injury or death from using a specific product, the FDA may force the product to be taken off the market. These items must be immediately removed from stock and a replacement item found. In some instances, the medical center may not receive credit from the manufacturer.

Summary

Regardless of which automated systems are in place or what inventory types are maintained, the basic inventory management process is the same.

- Required items are identified by user. Standards Committee reviews requests in order to standardize and reduce costs.
- Supply levels are identified in conjunction with the user.

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- Supplies are ordered, logged into the system, and stored. If an item must be backordered, the user must be notified and offered a substitution.
- As supplies are distributed or used, they are logged out of the system. The system monitors use and identifies supplies to be reordered based on preset levels.
- Supplies may be ordered automatically or manually. When they are delivered they are logged into the system and the process repeats.
- Periodic inventories of items in storage help to match what is on the shelf with what is in the system.

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✓ Check What You Know

1. Match the inventory type to its description.

Primary	No cost inventory approach
Primary vendor	Supplies stored within SPD
Secondary	No primary inventory is maintained by SPD. Stock is delivered to user areas by vendors, 2-3 times a day, 7 days a week
Consignment	Supplies stored at point-of-use
Just-in-time	Reduces primary inventory and delivers supplies for secondaries as needed

2. Effective inventory management…
    a. Delivers the right product
    b. Delivers products at the right time, ready for use
    c. Reduces costs by eliminating inventory on hand
    d. Adheres to sound inventory management practices
    e. Eliminates all but the most necessary items in stock

3. _____ inventory is located within SPD and contains the largest variety of items.

4. _____ inventories include ward closets and nurse servers.

5. _____ inventory allows a vendor to maintain a portion of the primary inventory, billing the medical center periodically for items used.

6. _____ inventory may generate a one time boost in revenue because the vendor may purchase existing inventory.

7. The _____ _____ approach reduces the amount of stock on hand because the vendor acts as distributor for a portion of the primary inventory, providing next day delivery on most item.

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8. Most effective when needs can be accurately forecast, _____ inventory allows SPD to take inventory and order stock for secondaries on a regular basis, just as things are needed.

9. _____ inventory eliminates the need for a primary inventory, providing deliveries of stock 2-3 times per day, 7 days a week.

10. Match the stock level to its description.

	Alerts SPD that item should be ordered
	Level of an item has fallen below the normal stock level but has not yet reached the standard reorder point
	The smallest acceptable amount of an item to be maintained in the primary
	The largest amount of an item that should be stored in SPD

Normal **Standard Reorder** **Optional Reorder** **Emergency Stock**

11. The _____ report identifies items that have not been used recently.

12. To determine which department consumed the most supplies in a given quarter, you would use the _____ report.

13. To determine if use of a particular item was on the increase, you would use the _____ report.

14. To avoid running out of something, you should check the _____ report.

15. _____ equipment automatically records supplies as they are used.

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16. _____ refers to the amount of time an item is expected to remain sterile in storage.

17. The Commodity Standardization Committee…
    a. Evaluates products for the medical center
    b. Insists that all doctors use the same brand of supplies
    c. Refuses to allow multiple supply vendors
    d. Attempts to reduce costs by eliminating unnecessary purchases

18. Describe each of the following types of recall.
    a. Biological test failure

    b. Manufacturer

    c. FDA

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Terminology

The following terms were used in this module.

inventory	Supplies or equipment in stock, available for use.
inventory management	Ordering, tracking and distributing supplies so that necessary supplies are available for use.
overstocked	Having more supplies on hand than are necessary.
under stocked	Having fewer supplies on hand than are necessary, risking a shortage.
secondaries	Storage facilities in the user area. These include nurse servers and ward closets.
Shortage	When necessary supplies are unavailable for use.
cost containment	Managing expenses so that needs are met in the most economical manner, avoiding the need to increase funding
prime vendor	The company that serves as the main supplier of medical supplies and equipment
commodity	Something bought or sold
fill rate	The number of items of a request that are available to place on the shelf (if 40 items were requested and 40 were distributed then the fill rate would be 100 percent)
point-of-use	Occurring at the location where an item is put into service

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Module 9 - INVENTORY MANAGEMENT

1. INVENTORY MANAGEMENT IS?

A. ORDERING INVENTORY ONLY WHEN THE LAST ITEM HAS BEEN USED
B. FRME WORK THATSUPPORTS ALL THE OTHER SPD TASKS AND ENSURES THAT MEDICAL SUPPLIES AND DEVICES ARE AVAILABLE REQUIRED.
C. SUPERVISOR OF SPD
D. DOES NOT EXIST

2. INVENTORY MANAGEMENT IS THE RESPONSIBILTY OF

A. THE DIRECTOR
B. CHIEF OF SPD
C. ALL SPD EMPLOYEES
D. NURSING STAFF

3. CONSIGNMENT ARRANGEMENTS ARE?

A. PROVIDES A SCHEDULED DELIVERY OF SUPPLIES
B. CONSIDERED "NO COST" INVENTORY BECAUSE MEDICAL CENTER ONLY PAYS UPON USE
C. IS A LABOR FREE SYSTEM
D. ALL OF THE ABOVE

4. NORMAL STOCK REPRESENTS?

A. WHATEVER EACH TECH FEELS IS RIGHT
B. THE LARGEST AMOUNT OF STOCK THAT IS MAINTAINED ON SPD SHELVES
C. IS AN EXCESS OS STOCK TO ASSURE THAT THE LEVEL NEVER GETS TO A REORDER POINT.
D. THE LEST AMOUNT OF STOCK SPD HAS

5. TO CALCULATE STANDARD REORDER LEVELS YOU?

A. JUST FILL IN THE NUMBERS THE COMPUTER DOES ALL THE WORK
B. TAKE DAILY USE AND THEN ADD AMOUNT OF TIME REQUIRED TO OBTAIN REPLACEMENT STOCK
C. THE NUMBER ONE IS ALWAYS THE REORDER NUMBER
D. STANDARD REORDER LEVELS ARE NOT NEEDED

6. IN SECONDARY INVENTORIES YOU HAVE?

A. STOCK LEVELS AND REORDER POINTS
B. NORMAL STOCK LEVELS BUT NO REORDER POINT LEVELS
C. ORDER POINTS THAT ARE TWICE THAT OF THE PRIMARY
D. NONE OF THE ABOVE

7. SPD'S GOAL IN INNVENTORY MANAGEMENT IS?

A. TO HAVE MANY EMEREGENCY ORDER AS POSSIBLE
B. HAVE AT LEAST 50% OF OUR ITEMS GO OUT OF STOCK
C. TO HAVE ENOUGH SUPPLIES FOR USERS WHEN REQUIRED WITHOUT INCURRING UNNECESSARY COST BY MAINTAINING EXCESS AMOUNTS OF STOCK
D. INVENTORY MANAGEMENT IS ONLY A THEORY.

8. PROBLEMS CAUSED BY OVER STOCKING SUPPLIES ARE?

A. TIES UP CONSIDERABLE AMOUNTS OF MONEY
B. INCREASES THE POSSIBLITY OF OUTDATING AND DAMAGE
C. NONE OF THE ABOVE
D. BOTH A & B

9. POINT OF USE EQUIPMENT PROVIDES?

A. CONTROLLED ACCESS TO SUPPLIES
B. KEEPS TRACK OF USAGE PATTERNS
C. GENERATES A PICK LIST
D. ALL OF THE ABOVE

10. THE PRIMARY INVENTORY POINT?

A. IS LOCATED INSIDE OF SPD
B. CONTAINS THE LARGEST AMOUNTS OF SUPPLIES
C. IS IN ALL SUPPLY CLOSETS
D. BOTH A & B

11. THE COMMODITY STANDARDS COMMITTEE?

A. EVALUATES PRODUCTS FOR USE IN THE MEDICAL CENTER
B. REDUCES THE NUMBER OF DIFFERENT KINDS OF THE SAME ITEM
C. REDUCES PERSONNEL PREFERENCE PURCHING
D. ALL OF THE ABOVE

12. WHICH IS NOT AN OFFICIAL RECALL REASON?

A. NOTIFICATION FROM FDA
B. A POSITIVE BIOLOGICAL INDICATOR
C. OVERSTOCKED ITEMS
D. NOTIFICATION FROM MANUFACTURER
E. NONE OF THE ABOVE

13. EFFECTIVE INVENTORY MANAGEMENT ?

A. DELIVERS THE RIGHT ITEM
B. DELIVERS AT THE RIGHT TIME
C. REDUCES COSTS BY ELIMINATING INVENTORY ON HAND
D. ELIMINATES ALL BUT THE MOST USED STOCK
E. A & B & C ONLY

Section Ten: Anatomy & Physiology

Estimated Contact Time:
120 -160 minutes

This module covers:

…the components, functions and the terminology associated with the study of the human body. It also describes illnesses that can affect the body and equipment that is used in treatment. This module is an overview, intended to help you become familiar with the human body so that you can better understand the supplies and equipment that are used in its care.

Following instruction, you should be able to perform the following:

- ☑ List ten major body systems and identify their role and function within the body.
- ☑ Identify terms associated with human anatomy and physiology. Locate (identify anatomical positions of) main components of each bodily system.
  - Identify articulation types
  - Diagram blood flow
  - Detail the digestive process
  - Detail the human reproductive process
- ☑ Identify the basic structure and function of a human cell.

Understanding the Human Body

Your body is an incredibly sophisticated organism made up of billions of individual living cells. Cells combine into tissues, tissues combine into organs and organs combine to form systems. The systems allow you to walk, talk, breathe, think, and be you.

Anatomy is the study of the structure of the human body – its components and how they are put together. Even more amazing than the structures themselves, is how they work together to do what they do. ***Physiology*** is the study of how the body functions.

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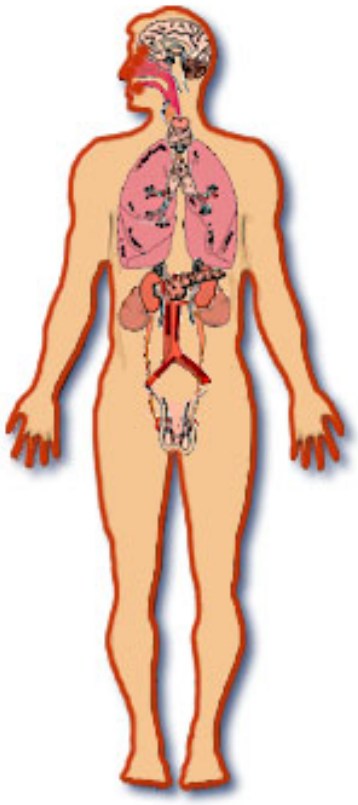
Medical supply technicians need a basic knowledge of human anatomy, physiology, and ***cytology*** in order to understand the reasons for policies and procedures regulating the processing, storing, and distribution of supplies and equipment used for patient care.

For convenience and to help understand how different components relate to one another, the study of the human body is often organized into systems.



- Skeletal
- Muscular
- Nervous
- Vascular
- Digestive
- Respiratory
- Urinary
- Reproductive
- Endocrine
- Sensory

A system is defined as a group of components that work together to perform a specific function. Each of the above systems has a specific job to do. The following sections describe each system.

Skeletal System

The skeletal system provides the framework for the other body systems and is composed of 206 bones. Bones have several important functions. They provide structure and support for the soft tissues, form protective cages around vital organs, allow movement by providing anchor points for muscles and manufacture red and white blood cells.

Bones are classified by their shape and composition. They can be long, short, flat or irregular and each shape can be cancellous

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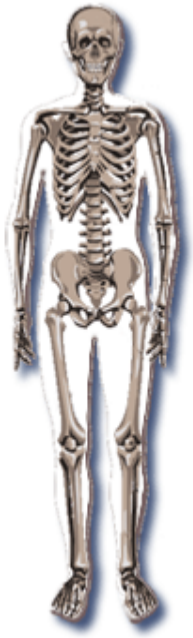

(spongy) or cortical (dense). They are made of calcium, phosphorus and bone marrow, making them both strong and light. The study of bones is called osetology.

Bones are made of connective tissue that is strong as steel but light as aluminum. The marrow is the center of the bone, where red blood cells are produced. The strong, flexible tissues that connect bones together are called ligaments. The point where two bones meet is called a joint. Joints allow the body to bend and move. Synovial fluid and membranes act as cushioning and lubricants in the joints, preventing the bones from rubbing together and causing damage. Bones are not completely rigid and can grow and regenerate after injuries.

Components

- **Long bones** – Include the bones of the arms and legs – the humerus, radius, fibula, and femur, the largest bone in the body. The ends of the long bones contain the soft tissue, which produces blood cells.
- **Short bones** – includes the bones of the fingers and toes – carpals, metacarpals, tarsals, metatarsals, and phalanges.
- **Flat** – Exist to protect vital organs. They include the ribs and scapula (shoulder blades).
- **Irregular bones** are found in the skull and pelvis. They include the illium, the bones of the skull and the smallest bones, the ossicles of the middle ear.
- **Cartilage** – Most bones start out as cartilage and ossify or harden as they mature. The ends of the long bones are covered with cartilage. It forms into columns that push older cells toward the middle of the bone shaft – causing the bone to lengthen or grow. Most bones stop growing between the ages of 17 and 25.
- **Ligaments** – strong bands of connective tissue which help to hold the bones in place and provide stability to joints (bone-to-bone).
- **Tendons** – strong connective tissue that connects muscle to the bone.
- **Bone marrow** – Bone marrow produces red blood cells.

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- **Spinal column** - The spinal column holds the body upright, supports the skull and protects the spinal cord.

Terms and Procedures

There are a number of conditions that affect the skeleton. A broken bone is called a fracture. Osteolitis is the inflammation of a bone. Osteoporosis is a decrease in the bone density causing the bone to become thinner and more porous. It can lead to fractures and curvature of the spine. Disk prolapse is when the pad of cartilage between spinal vertebrae ruptures. A microdiskectomy is an operation to repair this damage. A craniotomy is any operation on the cranium (skull), and the instrument that would be used to cut the cranium is a craniotome.

Terminology

- **cephal** - head
- **crano** - skull
- **osteo** - bone
- **sacro** - sacrum *(tailbone)*
- **thoraco** - chest
- **ischi -** hip
- **calc** - foot *(calcaneous bone)*
- **costa** - rib
- **oss** – bone

Joints

A joint is formed where two bones meet. The study of joints is called arthrology. Joints are classified by the way they move and there are three distinct types in the human body.

- *Fibrous or fixed joints* (synarthrosis) allow limited movement, generally for growth. As the body matures, the joints harden and movement ceases. Fibrous joints are held together by ligaments. Ligaments are tough, collagenous bundles of tissue that allow very little movement. The connections between the bony plates of the skull and the attachment of the teeth to the jawbone are examples of this type of joint.
- *Cartilagenous joints* (amphiarthrosis) are held together by cartilage and are partially moveable. The spinal column is an example of a cartilagenous joint. A thick disk of cartilage connects the individual vertebrae and allows the column of bone to twist and bend. It also absorbs most of the impact from the force of walking.
- *Synovial joints* (diarthrosis) move in many directions. The ends of the bone are connected by ligaments and cartilage, but separated by a cavity filled with synovial fluid. Synovial fluid is

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a clear, sticky liquid that helps lubricate and protect the joint as it moves. The shoulder, elbow, knee, wrist, and ankles are examples of this type of joint.

Terms used to describe joints:

- **synovial membrane** – thin delicate layer of connective tissue which secretes thick, viscuous synovial fluid, there are three types which occur in joints; bursal, articular, and vaginal.
- **cartilage** – Slick, elastic tissue that thinly covers bones, helping to prevent friction when bones touch, found in joints.
- **fibrous membrane** – The strong, lining or coating around membranes.
- An **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.

Terminology

- **artho** - joint
- **chondro** - cartilage
- **articul** - joint
- **fibro** - connective tissue
- **synovi** - synovial fluid

Muscular System

All the body's movements are powered by muscles. Different types of muscles enable motion, generate heat to maintain body temperature, move food through the digestive tract and contract the heart. There are more than 600 muscles in the human body. They can be divided into several types:

- **voluntary** (or skeletal),
- **involuntary** (or visceral), and a subcategory of involuntary,
- **cardiac** (heart).

Voluntary

The voluntary or skeletal muscles are the ones that are attached to bones and allow you to move about. They are also called striated muscles because under a microscope they appear striped.

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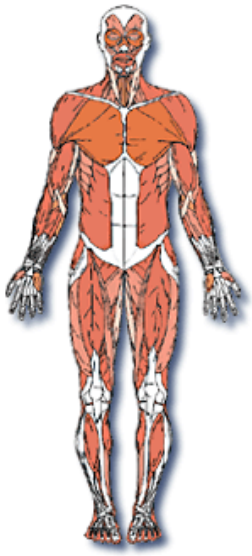

Voluntary muscles are made up of bundles of muscle fibers and are attached to bones by tendons, which are tough, white, cords of inelastic muscle tissue. Movement occurs when these bundles contract and extend. Many of these muscles are arranged in pairs across a joint; one contracts and pulls the bone, then relaxes while it's partner contracts and pulls it back.

Involuntary

Involuntary muscles (visceral) provide for the movement of blood throughout the vascular system. They also aid in the digestion of food. *Peristalisis* is the wavelike motion of the muscles of the large and small intestine which pushes food through. 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. They appear smoother and are often referred to as smooth muscles.

Cardiac

The cardiac muscle is unique 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 rhythmic action. The sounds created by the movement of this muscle can determine normal or abnormal functioning of the heart.

Did you know?

The cardiac muscle wins the endurance award. From the moment it begins beating until the moment it stops, the human heart beats nonstop. In an average lifetime, the heart beats more than two and a half billion times, without ever pausing to rest.

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Terms and Procedures

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

Terminology
my - muscle
ten - tendon

Due to the current focus on personal training and fitness, the names of many muscles are familiar to most people.
How many do you recognize?

Mastoid	Aductor longus	Gluteus maximus
Trapezius	Occipitofrontalis	Soleus
Deltoid	Mastoid	Vastus lateralis
Pectoral	Trapezius	Latissimus dorsi
Biceps	Deltoid	
Gluteus medius	Triceps	
Soleus	Biceps	

Did you know?
The word muscle is from the French “mus”, meaning “a mouse”.

Nervous System

Nerves help to control and coordinate the whole body, allowing it to receive stimuli from the environment and react to it. The nervous system has two divisions; the central system made up of the brain and spinal cord, and the peripheral system which consists of the nerve fibers, ganglia.

Components

The *central nervous system* has two components; the brain and the spinal cord. The spinal cord weighs about 35-40 grams and is about 43 cm long in adult women and 45 cm long in adult men. The vertebral column, the collection of bones (back bone) that houses the spinal cord, is about 70 cm long. Therefore, the spinal cord is much shorter than the vertebral column.

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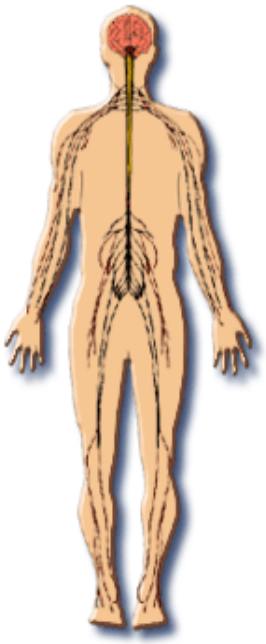

- **Brain** – The brain is the command center for the central nervous system; without its interaction the human body is considered clinically dead. The medulla oblongata, which is located at the base of the brain, controls our heartbeat, respiration, and body temperature.
- The **cerebellum**, which 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). In the average adult human, the brain weighs about 3 pounds and contains about 100 billion nerve cells (neurons) and trillions of "support cells" called glia.
- **Spinal cord** - The spinal cord is the main pathway for information connecting the brain and peripheral nervous system. 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.

Terms and procedures

- **Nerve fibers** - 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 is responsible for receiving incoming messages and

Terminology

- **encephalo** - brain
- **myel** - spine
- **mening** - membrane
- **neuro** - nerve
- **spina** - spinal cord

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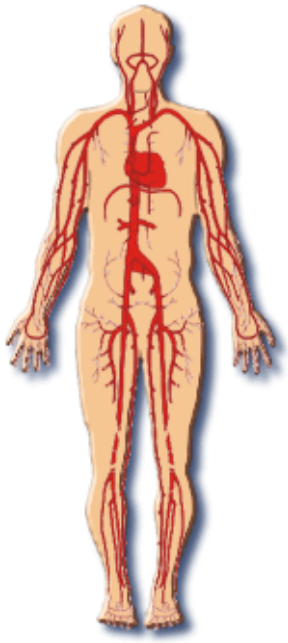
resembles tree branches and, and the axon, which is generally a single extension that transmits messages to the next neuron.

Nerve cells do not reproduce themselves.
Once they are destroyed or damaged they will not be replaced.

-
- ***Ganglia*** are connections between the spinal cord and the peripheral nervous system.
- ***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 radiopaque dye.

Vascular System

The vascular or circulatory system has two components, the lymphatic system and the blood vascular system**.**



Blood Vascular

The blood vascular system consists of the heart, arteries, arterioles, capillaries, venules, veins, and blood. It is responsible for transporting oxygen, nutrients, minerals, chemicals, disease fighting cells, and hormones to all parts of the body and removing waste products and carbon dioxide. The circulatory system allows us to regulate body temperature and *electrolyte* balance.

Components

The **heart** is a four-chambered muscular pump which facilitates the circulation of blood. The right atrium receives blood from the body and pumps it into the right ventricle. From

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there it travels to the lungs where it picks up oxygen, and then back to the the left atrium and the left ventricle. These chambers contract in pairs, first the atriums and then the ventricles.

The **right atrium** receives blood from the upper part of the body through the superior vena cava and from the lower part of the body through the inferior vena cava**.** It is then pumped into the right ventricle. The **right ventricle** pumps blood through the pulmonary arteries into the lungs where it receives oxygen. The **left atrium** then receives the blood from the lungs via the pulmonary veins. The pulmonary arteries and veins are unique in that the pulmonary arteries are the only arteries in the body that carry unoxygenated blood and the pulmonary veins are the only veins in the body that carry oxygenated blood. From the left atrium the blood flows into the **left ventricle**, which pumps it out through the aorta, the largest artery in the body.

Did you know?

The heartbeat sound is caused by the valves between the atriums and the ventricles opening and closing.

Arteries (except for the pulmonary arteries) carry oxygenated blood away from the heart to the tissues of the body. Arteries branch off into **arterioles**, which further branch off into **capillaries. Capillaries** are where nutrients, oxygen, and other products are absorbed for use by the body's tissues.

Veins (except for the pulmonary veins) carry deoxygenated blood back to the heart from the tissues. The venous system relies on daily activities to push blood back to the heart. The simple act of walking causes muscles in the legs to contract and extend which squeezes and pushes blood along the veins. Waste products are removed from the tissues by **venules**, which are branches of the veins.

Blood is the fluid that is circulated through the heart, arteries, capillaries, and veins. Blood carries nutrients and oxygen to the body's cells and removes wastes. It consists of:

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- **plasma** - a pale yellow liquid which gives the blood it's volume,
- **erythrocytes** - red blood cells that are saturated with *hemoglobin* **(**Oxygen attaches to the hemoglobin and is carried to the cells),
- **leukocytes** - white blood cells which vary in size and are focused on destroying pathogenic organisms. White blood cells seek out and attack unknown substances and pathogens. If a white blood cell is alerted to the presence of unwanted bacteria in the blood, it will find the bacteria and surround it. After a type of white blood cell (a T cell) has the bacteria trapped, it releases a deadly toxin that destroys the bacteria by breaking its outer membrane.
- **thrombocytes** - platelets which aid in the clotting of blood.

Terminology

- **angio** - vessel
- **arterio** - artery
- **cardio** - heart
- **erythr** - red
- **hemo** - blood
- **leuko** - white
- **phleb** - vein
- **vas** - vessel

Did you know?

There are approximately 5 quarts of blood, recycled through the heart once every minute, in the average adult body. In 24 hours, 7,200 quarts of blood pass through the heart.

Terms and Procedures

With the prevalence of heart disease, many of the terms associated with the vascular system are becoming household words. ***Angina*** is the term for chest pains that come on with exertion, signaling that the heart muscle is not getting enough oxygen. ***Atherosclerosis*** is the build up of fatty deposits in arteries, is usually the cause of coronary heart disease. Buildup in critical areas can require a surgical procedure called balloon angioplasty, where a balloon catheter is inserted to clear out a blocked artery. A swelling in a weak section of an artery wall is called an ***aneurysm.***

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Blood clots can lead to ***thrombophlebitis*** (inflammation of a vein). If a blood clot (***thrombosis***) becomes mobile and occludes (completely blocks) a vessel in the heart, it can cause a heart attack. Thigh-length and knee-length compression devices are used on bed-ridden patients to prevent venous stasis (pooling of blood in the extremities).

A ***defibrillator*** is a device that is designed to deliver an electric shock to the heart muscle to regulate or restart contractions. If someone's heart requires constant stimulation, a battery operated pacemaker may be installed in the chest wall to regulate heart contractions by electrical impulse. ***Hemostats*** are clamps that are used to prevent bleeding from blood vessels during surgery.

Problem	Description	Treatment
Arrhythmia	Irregular heartbeat	Pacemaker
Atherosclerosis	Build up of fatty deposits in artery	Balloon angioplasty
Hypertension	Persistently elevated arterial blood pressure	Lifestyle changes and drug therapy
Pericarditis	Inflamation of the membrane surrounding the heart	Anti-inflammatory drugs and sometimes surgery
Myocardial infarction	Heart attack	Coronary artery bypass

Lymphatic System

The lymph system has two main functions:

- draining excess fluid and removing dead white blood cells, then transporting them away from tissues and;
- helping the body fight infection by manufacturing and distributing white blood cells.

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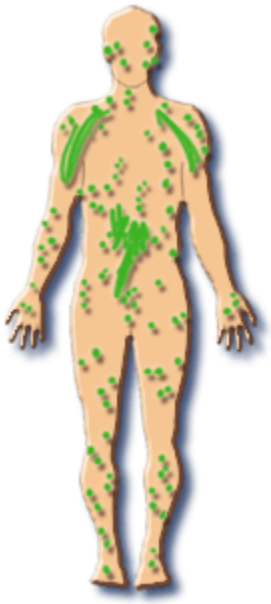
The lymphatic system consists of thin walled capillaries, larger lymphatic vessels, and lymph nodes. Lymph is constantly moving around the body. Unlike the heart-driven circulatory system, the lymphatic system has no pump but circulates by means of the movement of the body's muscles. Exercise and exertion helps push fluid from the body tissues through the lymphatic system.



Components

- **Lymph vessels** – The lymph system contains a network of vessels that assists in circulating body fluids. These vessels carry *lymph* - a clear, watery fluid containing lymphocytes, and their main function is to act as "drains" to collect excess fluid, transport it away from interstitial spaces in body tissue and return it to the bloodstream. Lymph vessels are found throughout the body and can be superficial, lying just beneath the skin, or deep, dispersed throughout the tissue of the cranial, thoracic, and abdominal cavities.
- **Lymph nodes** – Filter out destroyed microorganisms and are largely responsible for our disease fighting processes. Cells that eat up disease producing cells, called lymphocytes are concentrated in the lymph nodes and, as the lymph fluid passes through the nodes, it is filtered, recycled and directed back to the vascular system for recirculation throughout the body. The lymph nodes are located throughout the body along the lymph vessels. They are imbedded deeply in connective tissue so they are rarely seen. They are found in larger clusters in the axillary (arm pit area), inguinal (pubic/groin region), and cervical regions of the body.
- **Tonsils** – A pair of masses of lymphoid tissue located on either side of the throat.

Terminology

- **lymph** - water *(lymphatic)*

Terms and Procedures

- **Tonsillitis** is a bacterial or viral infection of the lymphoid tissue of tonsils. **Tonsillectomy** is the removal of the tonsils.

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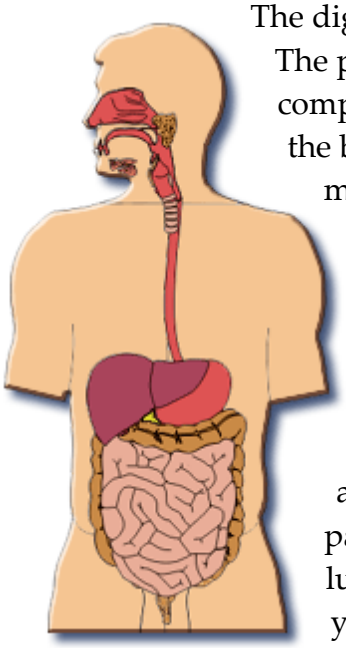
- **Lymphangitis** is a bacterial infection that has spread from its initial site (skin cut, etc.) to nearby lymph glands.
- **Lymphomas** – is the medical term for cancer. The specific cause is unknown, but it is thought to be associated with the complex chemical processes associated with the body's immune defenses. Treatment often involves chemotherapy, radiation, or removal of the affected area.

Digestive System



The 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 and transported to the body's cells. The main functions of the digestive system are to take in nutrients and eliminate waste. The digestive system is basically a 30-foot long tube, (**alimentary canal**) that runs from the mouth to the anus, and acts as a conduit for the digestive process. Digestion starts before you ever take a bite, when the sight and smell of food causes the central nervous system to alert the accessory organs. These organs; the salivary glands, pancreas, and stomach, secrete a watery solution that lubricates the alimentary canal and make it easier for your body to break down the food. The solution contains enzymes that help prepare the food to be absorbed into your bloodstream. The movement of food is helped along by peristalsis, the wave like motion caused by the involuntary muscles of the alimentary canal.

Almost all the organs that make up the digestive system can be bypassed or removed, and life can still be maintained, using feeding tubes which deliver nutrients 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.

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Components

- ***Mouth*** – In the mouth, food is mixed with saliva (which is secreted by the salivary glands) chewed, and swallowed.
- ***Esophagus*** – The muscular tube through which food passes from the mouth to the stomach.
- ***Stomach*** – The stomach is a large muscular organ, which mixes the food with the secretions from the gastric glands and converts the contents into a semi-liquid called ***chyme***.
- ***Small intestine*** – Most of the absorption of nutrients and water takes place in the small intestine which is divided into three parts: the duodenum, jejunum, and the ileum. The small intestine is the longest segment of the alimentary canal, averaging about 23 feet in length. In the small intestine, chyme is mixed with secretions from the liver, biliary tract and the pancreas, breaking it into compounds that can be readily absorbed into the bloodstream.
- ***Large intestine*** – Material that is not absorbed in the small intestine flows into the large intestine where more water is absorbed into the bloodstream. The large intestine consists of five sections:
    - the ascending colon,
    - transverse colon,
    - descending colon,
    - sigmoid colon,
    - rectum, and
    - anus.

- ***Rectum*** – Collection site for solid waste matter.
- ***Anus*** – Strong circular muscle through which fecal matter (solid waste) is excreted from the body.
- ***Biliary tract*** – The biliary tract secretes and transports bile for use in digestion. It includes the hepatic duct which drains from the liver, the cystic duct which drains from the gall bladder and the common bile duct which leads to the small intestine.
- ***Salivary glands*** – Located in the mouth, the salivary glands are responsible for production and secretion of saliva (spit).

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- ***Pancreas*** – a large gland that secretes digestive enzymes that help break down proteins, carbohydrates and fats. It secretes insulin into the digestive system via the pancreatic duct.
- ***Liver*** – The liver secretes bile for use in digestion. It is also responsible for purifying blood by removing and breaking down chemicals that could be harmful to the body. Without the liver, life cannot be sustained.
- ***Gall bladder*** – The gall bladder stores bile until it is needed for digestion. Bile is required for the breakdown of fats into simpler compounds.
- ***Spleen*** – acts as a reservoir for red blood cells, and supplies additional ones as needed for digestion

Terms and Procedures

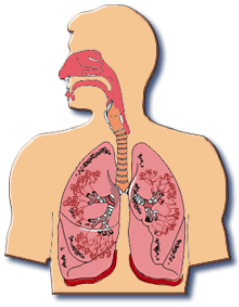
A ***cholecystectomy*** is the surgical removal of the gall bladder. A ***colonoscopy*** is the visual inspection of the colon using a flexible endoscope. A proctoscope allows examination of the rectum and anus. A gastroscope is used to view the stomach.

Stomatitis is the inflammation of an opening, while ***ileostomy*** means the surgical creation of a stoma (mouth) in the ileum, through the abdominal wall, for the removal of fecal wastes.

Terminology

- **chol** - bile
- **col** - colon
- **gastro** - stomach
- **gloss** - tongue
- **hepat** - liver
- **ileum** - small intestines
- **insul** - insulin
- **oral** - mouth
- **proct** - anus
- **sial** - saliva
- **stomata** – mouth*(opening)*

Respiratory System



The primary function of the respiratory system is to supply oxygen and remove carbon dioxide through ventilation or breathing. Oxygen enters the mouth and the nose, and passes through the ***larynx*** and the ***trachea***. The trachea splits into two smaller tubes called the ***bronchi***, which then divide into ***bronchial tubes***. The bronchial tubes lead directly into the lungs where they subdivide many times, ending in tiny sacs called ***alveoli***.

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Oxygen passes into the blood stream from the aveoli through ***capillaries***. Carbon dioxide from the blood enters the alveoli and travels back up the same path on the return breath. This exchange of oxygen and carbon dioxide at the cellular level is called respiration.

The main components of the respiratory system are often referred to as the respiratory tree because they resemble an upside down tree with the trachea as the trunk and the bronchioles and alveoli as stems and leaves. Infections of the respiratory tree are very common and are often caused by viruses or bacteria that flourish in the warm moist air.

Components

- ***Nostrils*** (nose) – Opening for drawing in and exhaling air. When air first enters, it is warmed, moistened, and filtered by mucous and tiny hairs called cilia.
- ***Pharynx*** – The part of the alimentary canal situated between the mouth cavity and the esophagus that communicates through the Eustachian tubes to the ears.
- ***Larynx*** (voice box) - The larynx contains the vocal cords which vibrate as air from the lungs flows past them, creating sound.
- ***Trachea*** (windpipe) – The main airway to the lungs. The trachea splits to form the bronchi.
- ***Bronchi*** – Air passages into the lungs through the bronchi which branch off into progressively smaller passageways.
- ***Lungs*** – Each lung contains a tree of branching tubes that end in tiny air sacs called alveoli.
- ***Alveoli*** – Very small air sacs at the tips of the respiratory branches. This is where oxygen and carbon dioxide are exchanged into the bloodstream.
- ***Diaphragm*** – The diaphragm is a sheet of muscles that lies across the bottom of the chest cavity separating the thoracic and abdominal cavities. Its job is to help expand and contract the lungs, pulling air in and then pushing it out.

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Did you know?

The diaphragm is the main respiratory muscle. It expands and contracts about 12 to 17 times a minute, drawing in and pushing out about a pint of air with each breath. The rate and volume of air increase automatically if the body requires a greater oxygen supply.

Terms and Procedures

Respiratory infections are very common. They range from colds and bronchitis to emphysema and pneumonia (inflammation of the lungs). A ***pneumothorax*** is a collapsed lung.

Breathing is ***autonomic*** – the body does it without conscious thought. A respiratory center in the brain responds to levels of carbon dioxide in the blood and regulates the expansion and contraction of the lungs. When a patient is not getting enough oxygen they are said to be ***cyanotic*** (blue). A ***thoracotomy*** tray contains instruments used in making a surgical incision into the chest cavity.

Terminology

- **aer** - air
- **bronchi** - windpipe
- **cyan** - blue
- **nas** - nose
- **thorac** – chest
- **pleura** – lining of the lungs
- **pne** - breathing
- **pneum** - breath, air
- **pneumo** - lung
- **rhin** - nose
- **sin** - sinus (fold, hollow)
- **trache** - windpipe (trachea)
- **spir** - breathing

Urinary System

The urinary or renal system is responsible for filtering the blood and removing waste. This results in the formation and elimination of urine. The human body excretes about one and one-half quarts of urine daily.

Components

- ***Kidneys*** – Two bean-shaped organs located in the back upper left and right quadrants of the abdominal cavity. Tiny filtering units in the kidneys, called nephrons, form urine by removing waste liquids and excess water, salts, sugar, and protein from

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the blood. When you hear the word *nephro* it is referring to the kidneys.

Terminology

- **uro** - urine
- **neph** - kidney
- **cysto** - bladder

- ***Ureters*** – The ureters are thick walled tubes, up to 15 inches long, that connect each kidney to the urinary bladder. If they become blocked by a kidney stone or from renal diseases, the kidneys will continue to produce urine and eventually be destroyed.
- ***Bladder*** – A muscular sac where liquid wastes form the ureters are collected. The bladder stores the urine until it is eliminated outside of the body through the urethra. The bladder normally rests in the pelvic cavity but, as it fills with urine, it can rise up into the abdominal cavity.
- ***Urethra*** – The channel through which urine passes from the bladder, out of the body. In males, the ***prostrate gland*** encircles the urethra at the bladder's base.

Terms and Procedures

Hemodialysis is the process of removing waste products by artificial means. Blood is filtered through a dialysis machine which filters wastes from the blood. This must be done up to 3 days a week and takes about 4 hours.

Substances in the urine can concentrate and harden to form ***kidney stones***. If they do not pass out of the urethra on their own surgery may be required to remove them.

Incontinence is the involuntary leakage of urine and is more prevalent in women than in men.

Did you know?

The kidneys can filter one quart of blood per minute or 360 gallons per day.

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Reproductive System

The reproductive system is responsible for reproduction and producing hormones which influence the development of feminine and masculine characteristics.

The purpose of the reproductive system is creation of a new human being. The main organs of the male reproductive system are the testicles, the vans deferens, the prostate and the penis. The main organs of the female reproductive system are the mammary glands, ovaries, fallopian tubes and the uterus. The uterus provides the nest where a fertilized egg grows and develops into a baby.

Components

The reproductive system in the female is comprised of the ovaries, fallopian tubes, uterus, vagina (birth canal), and mammary glands.

- **Ovary** –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. At puberty, the folicles in the ovary begin to release ova or eggs, one or more mature every month and make their way down the fallopian tube into the uterus.
- **Fallopian tube** – There are two fallopian tubes, one on each side, which connect the ovaries to the uterus. They have funnel shaped ends with fringelike projections that surround the ovary and receive any ovum that are released.
- **Uterus** – If the egg is fertilized it implants itself in the endometrium – the lining – of the uterus, where it stays to be grown and nourished for 40 weeks. If no egg is fertilized, part of the lining sloughs off every month as part of the menstrual flow.
- **Cervix** – The lower, narrow opening at the bottom of the uterus. During the birth process it must widen or dialate to more than 10 times it's normal size.

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- **Vagina** – A muscular passageway between the uterus and the outside world, the vagina is lined with a mucous membrane which provides lubrication and creates an acidic environment that serves as a barrier to germs.
- **Clitoris** – The female equivalent of the penis, this organ contains spongy erectile tissue and nerve endings.
- 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.

Terminology

- **lact** - milk
- **mamm** - breast
- **mast** - breast
- **colpo** – vagina
- **ooph** - ovary
- **orchi** - testicle
- **gyn** - women
- **ova** - egg
- **hyster** - womb
- **salping** – tube
- **sperm** - seed
- **test** - testicle

The male reproductive system consists of the testes (testicles), penis, the vans deferens and prostate gland.

- **Penis** – The external appendage used for urination and sexual intercourse. Enclosing the lower section of the urethra, the penis is composed of columns of spongy erectile tissue. When these fill with blood, the penis becomes erect.
- **Prostrate gland** – a donut shaped organ, wrapped around the base of the bladder, the prostate gland produces a milky white alkaline secretion that becomes part of the seminal fluid. This fluid allows for the mobility of the sperm and protects it from the acidic conditions of the female vagina.
- **Vas deferens** – the tube that leads form the testicle to the prostrate gland
- **Epididymis** – A long coiled tube leading form the testes where sperm mature and are stored until ejaculated or reabsorbed into the body.
- **Testes** – A pair of rounded glands that lie in the scrotum. The testes produce spermatazoa which carry the male genes and the male sex hormone testosterone which is responsible for secondary male characteristics such as body hair.

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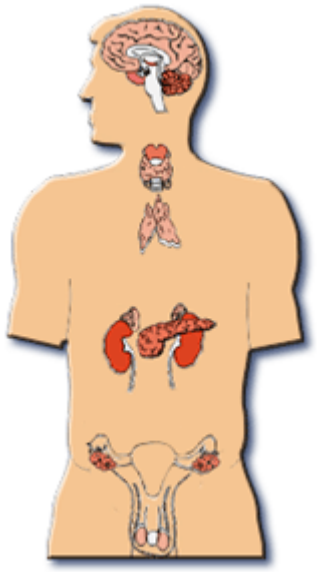
- **Seminal vesicle** – Produces a sugary fluid that provides the energy necessary for the sperm to swim.

Terms and procedures

- A ***hysterectomy*** is the surgical removal of the uterus.
- An ***orchiectomy*** 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.

Endocrine System

The endocrine system is unique in that its components are not physically connected. 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.



Components

The endocrine glands, though physically unconnected, are responsible for directing other parts of the body through the secretion of hormones. They are directly responsible for growth and development, the movement of chemicals in the body, blood pressure, labor and lactation, metabolism, stress responses, and other body functions.

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- **Pituitary gland** – Also called hypophysis, the pituitary is known as the master gland because it controls the functions of the other endocrine glands, helping to regulate skeletal growth, reproductive activities, muscle, and blood functions. In humans this gland is roughly the size of a garbanzo bean.

- **Thyroid gland** – Regulates metabolism and requires the compound iodine for normal function.
- **Parathyroid glands –** Control the amount of calcium in the blood. Usually there are four of these.
- **Adrenal glands** – Adrenal glands are responsible for how we respond to stressful situations. During emergency situations, the *suprarenals* secrete adrenalin which acts on smooth muscles, and increases the amount of glucose available for use by body tissues. This provides the energy necessary for the body to fight for its life or run away from the situation and is known as the "fight or flight" syndrome.

Terminology

- **adren** - adrenal gland *(suprarenal)*
- **insul** - insulin
- **thyr** - thyroid

- **Pancreatic islands** – Also called the islands of langerhans, these glands secrete insulin. Insulin regulates the sugar content of the body.
- **Ovaries** secrete hormones that control secondary female sex characteristics. These are covered more thoroughly in the reproductive section.
- **Testes** secrete hormones that control secondary male sex characteristics. These are covered more thoroughly in the reproductive section.
- **Thymus** – Regulates growth and *atrophies* with the completion of adolescence.

Terms and Procedures

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An **insulin pump** is a device, implanted under the skin, which delivers synthetic insulin in order to allow the body to metabolize sugar.

Thyropenia is a condition where the thyroid gland does not produce enough thyroid hormones. **Hyperthryroidism** (Grave's disease) is associated with enlargement of the thyroid. Surgery may be required to relieve pressure on the trachea or esophagus. A **thyroidectomy** is the surgical removal of the thyroid gland.

Sensory System

The body takes in information from the environment through the sensory system. The eyes, ears, nose, tongue and skin all contain receptors which help the body see, hear, smell, taste, and feel stimuli. These sensations are then passed to the brain via nerves.

Sensory organs

Sensory organs are designed to receive and interpret messages from the sensory nerves providing the capability of sight, sound, smell, and taste.

- The **eyes** are globular organs of vision (sight). There are three layers;
  - **Sclera** - the white, dense, inelastic membrane that helps the eye maintain its globular shape and provides protection,
  - **Choroid** - the thin, dark brown middle layer
  - **Retina** – 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 the lens. The rods and cones transmit the impressions to the brain by way of the optic nerves where they are interpreted.

- The **ear** is the sensory organ of hearing and equilibrium. It is divided into three parts:

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used or reproduced without permission.

- 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.

- 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.

- 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.

- The **skin** or *integument* is often overlooked as a system, but it is one of the body's most important organs. Nerve cells in the skin help the body communicate with its environment by allowing it to perceive pressure, pain, heat, cold and touch. The skin also helps regulate temperature and moisture in the body and prevents harmful substances from entering. It plays an important role in maintaining homeostasis.
    - The primary function of skin is to provide protection from the environment. It creates a barrier against infection and helps contain body fluids to keep deep

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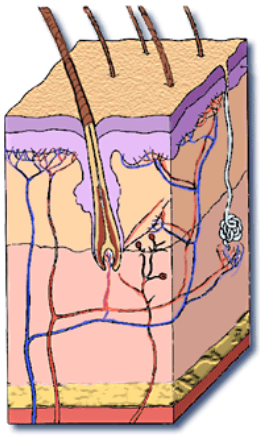
tissues moist and viable. Keeping the skin intact decreases our susceptibility to disease. Large areas of skin loss, as in burns, can be fatal due to loss of body fluids and infection.



Components

- **Epidermis** – The thin layer of epithelial tissue that forms the outer layer of skin. Its outer surface is made up of dead skin cells which are constantly being sloughed off and replaced by new ones from the layer underneath. The epidermis contains only a few nerve cells and no blood vessels. There are many delicate creases in the outer surface which help give skin its elasticity. On the palms of the hands and the soles of the feet, there are ridges and grooves that form intricate patterns, which we call fingerprints and footprints. These textures allow us to grip things.
- **Dermis** – Lying beneath the epidermis, the dermis is a thick layer containing a dense network of blood vessels and nerve cells. The blood vessels, called capillaries, provide nutrients to the skin tissue and help to regulate body temperature by expanding and contracting to control the amount of blood that is circulated near the surface. The nerve cells act as receptors to the nervous system, allowing the body to perceive pressure, pain, heat, cold, and touch.
- **Cutaneous glands** – There are two types: sweat (sudoriferous) and oily (sebaceous). Sweat glands help regulate body temperature by producing sweat which is excreted to the skin surface where it evaporates, carrying excess heat with it. Oily glands are located around hair follicles and secrete sebum which coats and protects hair follicles. Most pimples are caused by infection or blockage of the area around these glands.
- **Hair follicle** – Hair and nails are appendages of the skin. They are composed of dead skin cells which are hardened by a natural substance called keratin. Hair follicles are surrounded by nerve cells which increase our sense of touch. They are also surrounded by tiny bundles of smooth muscles which contract in order to cause the sebaceous glands to secrete sebum. These

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tiny clusters of smooth muscles are also responsible for giving rise to "goose bumps" when they contract as a group.

Did you know?

The patterns in a person's skin are unique. No two individuals have the same fingerprints or footprints, which is why they can be used to identify people.

Terms and Procedures

- A ***dermatologist*** is a physician who is concerned with the diagnosis and treatment of skin disorders. ***Dermatitis*** is an inflammation of the skin.
- Some skin cells release a pigment called melanin. Melanin determines skin color. Concentrations of melanin can produce freckles or moles. If a mole changes size, shape or color it may form a tumor or ***melanoma***. Melanoma may be malignant and should be removed.
- **Ophthalmoscopes** and **otoscopes** are instruments used to view the eyes, ears, and nose.
- A **rhinoplasty** tray contains surgical instruments used in nasal surgery.

Terminology

- **derm** - skin
- **hidr** - sweat
- **onych** - nail
- **sarc** - flesh
- **tact** – touch
- **gloss** - tongue
- **naso** - nose
- **sens** - sensory
- **ophthalm** - eye
- **ot** - ear
- **rhin** - nose

Cytology

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. Your body is composed of over 100 trillion cells, but they are too small to be seen with the naked eye. It would take at least 100 of them to cover the surface of this period.

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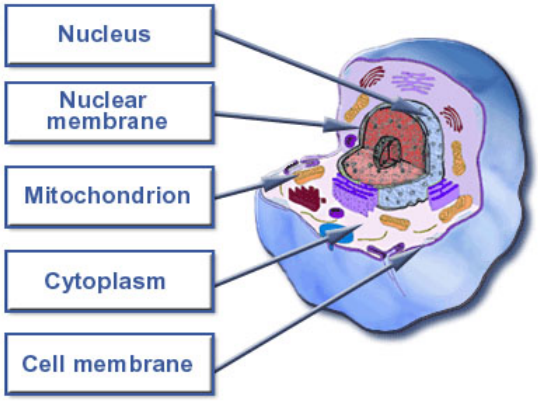
Although cells differ functionally, they all have common physical features and multiply by the same basic process. Cytology is necessary for the medical supply technician in order to understand how diseases are transmitted and how to control the spread of diseases through infection control mechanisms.

Components

- **Nucleus** – The nucleus of the cell contains DNA, a substance which carries information that determines the genetic or hereditary makeup of each individual. DNA (Deoxyribonucleic Acid) 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 individuals traits. During cell multiplication, DNA thins out into threads which become chromosomes. Each cell in the human body contains 46 chromosomes.
- **Nuclear membrane** – A nuclear membrane surrounds the nucleus. It is permeable – substances can pass through it.
- **Cytoplasm** – 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 cells functions. Cellular functions include protein synthesis and cellular metabolism (growth, maintenance, and repair).
- **Cell membrane** - The cell membrane surrounds the cytoplasm.
- **Organelles** - Organelles are chemical structures that allow the cell to live and grow.
- **Mitochondria** – Mitochondria are little organs in the cytoplasm. They produce energy for the cell's use.



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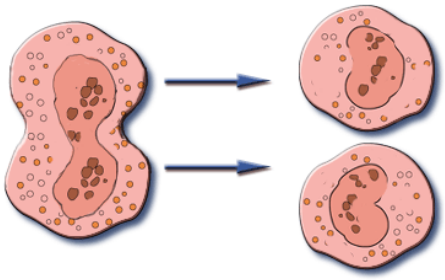
There are about 200 different kinds of specialized cells in the human body. New cells are needed on a continuous basis and the requirements change as we age. From infancy to adolescence, the human body requires numerous new cells for growth and development. As we age, new cells are required to replace those that die.

The skeletal systems 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. 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.

Mitosis – Cell Reproduction

Cells multiply by a process called mitosis. When the process is completed, two identical cells emerge.



1. The process begins when the 46 chromosomes thicken, contract, and form 23 pairs.
2. The pairs make 23 exact copies of themselves through a process called replication.
3. 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.
4. A new cell membrane forms across the middle of the cell, and the cell divides,
5. The chromosomes begin to lengthen, and two identical cells are formed.

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***. We are still learning about what causes oncogenes and how they function. ***Oncology*** is the study of tumors.

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Summary

In order to effectively perform the duties of an SPD technician, you must have a working knowledge of the main body systems, the problems that affect them and the procedures that are use din their treatment. This Module has provided an overview of the ten major systems and the terminology associated with each.

Skeletal

Bones are made of connective tissue that is strong as steel but light as aluminum. The marrow is the center of the bone, where red blood cells are produced. The strong, flexible tissues that connect bones together are called ligaments. The point where two bones meet is called a joint. Joints allow the body to bend and move. Synovial fluid and membranes act as cushioning and lubricants in the joints, preventing the bones from rubbing together and causing damage. Bones are not completely rigid and can grow and regenerate after injuries.

A joint is formed where two bones meet. Joints are classified by the way they move and there are three distinct types in the human body; fibrous or fixed, cartilaginous or partially movable, and synovial which are free moving and lined with a lubricant called synovial fluid. The study of joints is called arthrology.

Muscular

The muscular system covers most of the human body. Skeletal muscles expand and contract to move bones and allow us to walk, talk, and chew gum. We don't have to think about involuntary or smooth muscles. They work to maintain body functions like breathing and digestion. Cardiac muscles allow the chambers of the heart to expand and contract, circulating blood throughout the body.

Nervous

The nervous system allows your body to pick up information from the outside world and react to it. The brain is the control center for the whole body. It processes the messages from the peripheral nerves, decides how to react, and sends messages back to the motor nerves which tell the muscles and organs what to do. The

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peripheral nervous system handles both conscious and unconscious or autonomic functions.

Vascular

The vascular system circulates blood, transporting oxygen, nutrients, minerals, chemicals, disease fighting cells, and hormones to all parts of the body. It is also responsible for removing waste products and carbon dioxide. The blood circulation part of this system allows us to regulate body temperature and electrolyte balance, while the lymphatic part removes excess fluid and helps the body fight infection.

Digestive

Digestion, the process of taking in food and breaking it into compounds that can be absorbed into the bloodstream, takes place in the digestive system. It includes the mouth, esophagus, stomach, small intestine, large intestine, rectum, anus, biliary tract, pancreas, salivary glands, and the liver.

Respiratory

The respiratory system supplies oxygen and removes carbon dioxide. It is composed of a series of branching components, often referred to as the respiratory tree; nostrils, pharynx, larynx, trachea, bronchi, alveoli, lungs and the diaphragm. Respiratory infections are very common. They range from colds and bronchitis to *emphysema* and pneumonia (inflammation of the lungs).

Urinary

The urinary system regulates the volume and composition of fluids in the body and removes waste products. 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). The urinary tract is susceptible to infection and to chronic disorders.

Reproductive

The reproductive system is responsible for reproduction and producing hormones which influence the development of feminine and masculine characteristics. The reproductive system in the

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female is comprised of the ovaries, fallopian tubes, uterus, vagina (birth canal), and mammary glands.
The male reproductive system consists of the testes (testicles), penis, and prostate gland.

Endocrine

The term endocrine means "to secrete from within." The endocrine glands, though physically unconnected, are responsible for producing hormones which direct other parts of the body They are directly responsible for growth and development, the movement of chemicals in the body, blood pressure, labor and lactation, metabolism, stress responses, and other body functions.

Sensory

The eyes, ears, nose, tongue and skin all contain receptors which help the body see, hear, smell, taste, and feel stimuli. These sensations are then passed to the brain via nerves. The skin is one of the body's most important organs. It helps regulate temperature and moisture in the body and prevents harmful substances from entering. Keeping the skin intact decreases our susceptibility to disease. Nerve cells in the skin help the body communicate with its environment by allowing it to perceive pressure, pain, heat, cold and touch.

Cytology

Cytology is the study of cells. There are about 200 different kinds of specialized cells in the human body. Cell reproduction is called mitosis.

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✓ Check What You Know

1. Match each term to its description.

colonoscopy	a device used to view the stomach
proctoscope	the visual inspection of the colon by means of a flexible endoscope
gastroscope	device used to view the rectum and anal areas
stomatitis	surgical removal of the gall bladder
cholecystectomy	opening or mouth for the removal of fecal matter
ileostomy	surgical creation of an opening through the abdominal wall to the small intestine
stoma	inflammation of the mouth

2. Match the term to its meaning.

sebaceous	beneath the skin
dermis	flesh
sarc	sweat
hidr	skin
onych	nail
dermititis	oily
subcutaneous	skin infection

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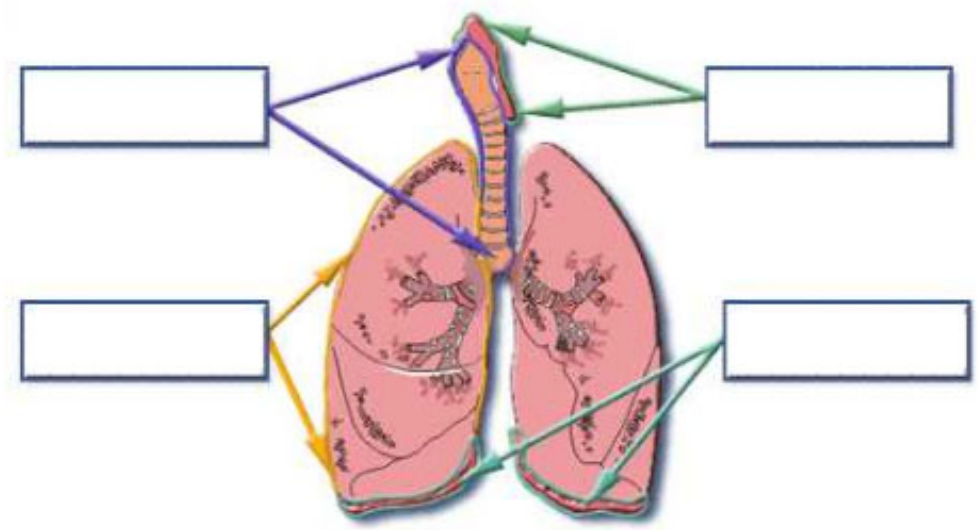
3. Label each component.



4. Match each respiratory term to its description.

_____ Allergic reaction which causes the smaller bronchi to constrict and become blocked with mucus

_____ Disease often brought on by long term smoking which causes the alveoli to rupture and burst

_____ Surgical procedure for removing a small portion of the lung, usually due to lung cancer

_____ Thin layered sac that encloses each lung

_____ Dome shaped muscle that separates the lungs from the abdominal cavity

a. Asthma
b. emphysema
c. lobectomy
d. bronchioscopy
e. pleural membranes
f. diaphragm

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5. Match each urinary system component to its description.

_____ Has a muscular wall, the detrusor muscle, which expands or contracts to accommodate changing volume

_____ Main function is to regulate the acidity and concentration of water in the body

_____ Tube from bladder for draining urine

_____ The inability to control urine flow

_____ Liquid wastes removed from the blood stream

_____ Urine making unit of the kidney

_____ Concretions of minerals, mostly calcium, which form in the kidneys

a. Incontinence
b. Urethra
c. Bladder
d. Kidney
e. Calculi
f. Urine
g. Nephron

6. Match each term to the related phrase.

Vas deferens	non-cancerous uterine tumor
Scrotum	sperm passageway
Pelvic cavity	woman's wider than man's
Puberty	most common male cancer
Fibroid	temperature regulation
Endometriosis	cysts form female organs
Prostate	pap smear

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Cervical onset of sexual maturity

7. Which of these are important for maintaining a healthy lymphatic system?
   a. Drink adequate amounts of good quality water
   b. Eat nutritionally balanced meals
   c. Exercise regularly
   d. Avoid exposure to the causes of disease and infection
   e. Avoid pollutants, toxic substances and unhealthy environments
   f. Manage stress

8. Match each description to the proper term.

   ____ Delivers synthetic insulin to allow metabolism of sugar

   ____ Removal of the thyroid gland

   ____ Inadequate production of thyroid hormones

   ____ Adrenal gland

   ____ Regulates body's sugar content

   ____ Insulin secretion

   a. insulin pump
   b. thyroidectomy
   c. thyropenia
   d. suprarenal
   e. insulin
   f. islands of langerhans

9. _____ is the study of muscles.

10. The three types of muscles are:

_____, involuntary, and _____.

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11. The nervous system has two divisions; the _____ which includes the brain and spinal cord, and the peripheral which consists of nerve fibers and ganglia.

12. _____ nerves control reflexive functions such as the working of the heart, stomach, lungs and intestines.

13. There are approximately _____ bones in the adult human body.

14. Bones are primarily composed of bone marrow, _____ and phosphorus.

15. What is the approximate amount of blood in the human body?

    a. 1 liter
    b. 26 pints
    c. gallons
    d. quarts

16. Match each term:

    ____ The study of the structure and function of cells

    ____ The study of growths formed by mutating cells

    ____ Cell reproduction

    ____ Threads of DNA formed in pairs

    ____ The jelly-like substance where cell metabolism occurs

    a. Cytology
    b. Oncology
    c. Mitosis
    d. Chromosomes
    e. Cytoplasm

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Terminology

The following terms were used in this module.

arterioles	small terminal twigs of an artery that end in capillaries
arthrology	the study of joints
atrophies	decreases in size or wastes away
autonomic nervous system	away the portion that controls unconscious actions such as heartbeat and breathing
capillaries	the smallest of blood vessels which connect arterioles with venules
cartilage	a tough fibrous connective tissue (also known as gristle)
collagenous	composed of the insoluble, fibrous protein – collagen – which makes up the organic matter in bones and connective tissue
cyanotic	a bluish or purplish discoloration of the skin due to insufficient oxygen in the blood
dermis	the sensitive, vascular, inner layer of the skin
electrolyte	a nonmetallic electrical conductor in which current is carried by movement of ions
emphysema	a local or generalized condition of the lung, characterized by distension and loss of elasticity
endocrine	producing hormonal secretions that are distributed throughout the body via the bloodstream
epidermis	the outer layer of the skin
epithelial	membranous cellular tissue that covers a free body surface or lines a tube or cavity
hemoglobin	an iron containing pigment in red blood cells that helps to transport oxygen
hemostasis	stoppage or sluggishness of blood flow
homeostasis	resistance to change, the efforts of an organism to maintain

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	its equilibrium
hormones	chemical messenger, produced by a cell that effects changes in other cells
Inferior vena cava	the largest vein in the body, which returns blood to the right atrium of the heart from the lower body
lactation	the secretion and yielding of milk by the mammary gland
ligaments	a tough fibrous band of tissue that supports bones, particularly in and around joints
lymph nodes	a small oval gland, attached to lymph vessels and packed with white blood cells that act as a barrier to infection
Lymphatic system	an extensive network of transparent vessels, responsible for removing excess fluid form cells
lymphocytes	small white blood cell, part of the immune system, protects against viral infections and cancer
metabolism	chemical changes in living cells during which new material is taken in and energy is provided for vital processes
pathogenic	disease causing
peristalsis	a coordinated series of muscular contractions and relaxations in a tubular muscle wall (such as the stomach). It's purpose is to move contents along
secretion	the process of forming and releasing a material for a specific function (as in the salivary glands secrete saliva)
Superior vena cava	the second largest vein in the body, which returns blood to the right atrium of the heart from the upper body
tendons	a strong band of collagen fibers that join muscle to bone, and transmit the pull that is a muscle contraction
venous stasis	a slowing of the current of the blood in the veins

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Module 10 - ANATOMY AND PHYSIOLOGY

1. THE STUDY OF THE STRUCTURE OF THE BODY IS CALLED?

A. PHYSIOLOGY
B. BIOLOGY
C. ANATOMY
D. MICROBIOLOGY

2. THE STUDY OF THE FUNCTIONS OF THE BODY IS CALLED?

A. PHYSIOLOGY
B. ANATOMY
C. CHEMISTRY
D. PODIATRY

3. BONES ARE CLASSIFIED BY THEIR?

A. LOCATION
B. DENSITY
C. SHAPE
D. COMPOSITION

4. OSTEOLITIS IS _____ OF THE BONE?

A. STUDY
B. PART
C. INFLAMMATION
D. PROXIMAL END

5. WHICH OF THE FOLLOWING ARE TYPES OF JOINTS IN THE BODY?

A. FIXED
B. CARTILAGINOUS
C. SYNOVIAL
D. ALL OF THE ABOVE

6. WHICH OF THE FOLLOWING ARE THREE TYPES OF MUSCLE TISSUES IN THE BODY?

A. VOLUNTARY, INTERCOSTAL, STRIPED
B. VOLUNTARY, INVOLUNTARY, CARDIAC
C. INVOLUNTARY, CARDIAC, LONG
D. CARDIAC, VOLUNTARY, SHORT

7. MUSCLES THAT ALLOW YOU TO MOVE AND ARE STRIATED ARE WHICH TYPE?

A. INVOLUNTARY
B. CARDIAC
C. VOLUNTARY
D. INTERCOSTAL

8. WHICH OF THE FOLLOWING IS AN INSTRUMENT THAT IS USED TO CUT MUSCLE?

A. OSTEOTOME
B. BABCOCK
C. DERMATOME
D. MYOTOME

9. THE CENTRAL NERVOUS SYSTEM IS MADE UP OF WHICH OF THE FOLLOWING PARTS?

A. THE BRAIN
B. CEREBELEIUM
C. SPINAL CORD
D. RETINA

10. PULMONARY ARTERIES ARE THE ONLY ARTERIES THAT CARRY_____BLOOD IN THE CIRCULOROTORY SYSTEM?

A. OXYGENATED
B. RED
C. UNOXYGENATED
D. BLUE

11. THE TERM ARTERIO IS RELATED TO WHICH OF THE FOLLOWING?

A. ARTERY
B. LUNG TISSUE
C. THE STOMACH
D. THE BRAIN

12. WHAT IS THE NAME OF THE PALE YELLOWISH SUBSTANCE THAT GIVES BLOOD ITS VOLUME??

A. LYMPH
B. CHYME
C. PLASMA
D. PROTEIN

13. HEMOSTATS ARE NORMALLY USED TO PREVENT _____ DURING SURGERY?

A. TISSUE TEARING
B. BLEEDING
C. CARDIAC ARREST
D. NONE OF THE ABOVE

14. A SWELLING IN A WEAK SECTION OF AN ARTERY WALL IS KNOWN AS_____?

A. BIFURCATION
B. VALVE
C. FEMORAL
D. ANEURYSM

15. MOST OF THE ABSORPTION OF NUTRIENTS AND WATER INTO THE BODY TAKES PLACE WHERE?

A. THE STOMACH
B. THE MOUTH
C. LARGE INTESTINE
D. SMALL INTESTINE

16. THE TERM "CHOLE" IS RELATED TO WHICH OF THE FOLLOWING?

A. BILE
B. PANCREAOUS
C. PLASMA
D. LYMPH

17. THE LARYNX AS ALSO KNOWN AS THE _____

A. THE TONGUE
B. THE VOICE BOX
C. THE ESOPOGUAGS
D. THE NOSE

18. THE PROCESS OF ARTIFICIALLY REMOVING WASTE PRODUCTS FROM THE BLOOD OF THE BODY IS KNOWN AS_____?

A. CLEANSING
B. VENIPUCTURE
C. INTERFERON
D. HEMODIALYSIS

19. THE TERM "ENDOCRINE" MEANS WHICH OF THE FOLLOWING?

A. TO BLEED PROFUSELY
B. TO SALIVATE
C. TO SECRETE FROM WITHIN
D. TO CRY

20. THE REGULATORY GLAND WITHIN THE BODY RESPONSIBLE FOR METABOLISM IS CALLED?

A. HYPOTHALAMUS
B. SPLEEN
C. THYROID
D. DIAPHRAGM

21. THE INTEGUMENTAL SYSTEM IS MADE UP OF WHICH OF THE FOLLOWING?

A. THE TONGUE
B. SMALL AND LARGE INTESTINES
C. THE STOMACH
D. THE SKIN

22. WHICH OF THE FOLLOWING ARE THE THREE SMALL BONES OF THE INNER EAR?

A. HAMMER, ANVIL, STIRRUP
B. HAMMER, ANVIL, SADDLE
C. HAMMER, NAIL, STIRRUP
D. ANVIL, HORSESHOE, STIRRUP

23. WHAT IS THE ENERGY PRODUCING PART OF A CELL IS KNOWN AS?

A. NUCLEUS
B. FLAGELLA
C. MITOCHONDRIA
D. PLASMA

24. WHERE IS INSULIN PRODUCED IN THE HUMAN BODY?

A. PANCREAS
B. LIVER
C. ISLANDS OF LANGERHANS
D. SMALL INTESTINE

25. MYCOLOGY IS THE STUDY OF WHAT?

A. BLOOD
B. THE BRAIN
C. MUSCLES
D. BONES

26. THE TWO DIVIONS OF THE NERVOUS SYSTEM ARE KNOWN AS?

A. CENTRAL
B. PERIPHERAL
C. CEREBELLUM
D. PITUITARY

27. THE STOMACH AND HEART ARE CONTROLLED BY TYPE OF NERVES?

A. VOLUNTARY
B. INVOLUNTARY
C. CARDIAC
D. STRIATED

28. HOW MANY BONES ARE NORMALLY IN THE HUMAN BODY?

A. 200
B. 190
C. 202
D. 206

29. AN ARTHROTOME IS AN INSTRUMENT USED TO CUT WHAT?

A. TISSUE
B. TENDONS
C. LIGAMENTS
D. BONES