Microbiology for Central Service

LEARNING OBJECTIVES
1. Define microbiology and explain its importance to Central Service technicians
2. Describe the history of microbiology
3. Identify and classify microorganisms
4. Explain the environmental conditions necessary for the growth, survival and destruction of microbes
5. Address the transmission of microorganisms in the Central Service department
6. Review basic procedures to control and kill microorganisms

OBJECTIVE 1: DEFINE MICROBIOLOGY AND EXPLAIN ITS IMPORTANCE TO CENTRAL SERVICE TECHNICIANS
Central Service (CS) technicians must have a basic understanding of microbiology, which is the study of microorganisms. “Micro” means too small to see with the naked eye; therefore, a microscope is necessary to see them. Microorganisms are measured in microns. A micron is equal to 1/25,000 of an inch or 1/2,000 of a millimeter. Most bacteria are 1 or 2 microns in size. Microorganisms are present everywhere in our environment; however, not all microorganisms are harmful. Only about 5% of microorganisms are pathogenic (disease causing). It is the responsibility of CS technicians to protect patients and themselves by eliminating pathogenic microorganisms in the healthcare environment. The tasks of the CS department, such as decontamination, disinfection and sterilization, will help accomplish this goal.

OBJECTIVE 2: DESCRIBE THE HISTORY OF MICROBIOLOGY
Microorganisms have always been present, but were first identified in the 1600s when Anton van Leeuwenhoek, a fabric tradesman, developed a microscope to better view the fabrics and cloths he would purchase. Using lenses that magnified material by as much as 200 times its normal size, van Leeuwenhoek discovered bacteria and opened the door to the study of microbiology. Another early pioneer in the world of microorganisms was Robert Hooke. He is best known for applying the word “cell” to describe the basic unit of life. Then, in the 1800s, Christian Gram developed crystal violet stain, called gram stain, that allowed the identification of gram-positive and gram-negative organisms; organisms that stain blue are gram positive and organisms that stain red are gram negative. Another microbiology pioneer of the 1800s was Louis Pasteur. He developed pasteurization, a process used to destroy microorganisms in food,
and also developed a vaccination for anthrax and rabies.

**OBJECTIVE 3: IDENTIFY AND CLASSIFY MICROORGANISMS**
The most common ways to identify and classify microorganisms is by their shape, color change and need for oxygen. Bacteria are divided into three main groups, according to their shapes.

- **Cocci** are round or spherical-shaped gram-positive or gram-negative bacteria, and can occur singularly or in pairs, clusters or chains. *Staphylococcus* bacteria occur in clusters and cause disease such as Methicillin-resistant *Staphylococcus aureus* (MRSA) and pneumonia. *Streptococcus* bacteria occur in chains and cause illness, such as strep throat, meningitis and necrotizing fasciitis (flesh-eating bacteria).

- **Bacilli** is rod-shaped gram-positive or gram-negative bacteria. The rods may be large and brick-shaped, or small and stick like. Disease-causing bacillus may include *Escherichia coli* (*E. coli*), which manifests as bloody diarrhea, and *Clostridium difficile* (*C. difficile*), which can manifest as a urinary tract infection and/or bloody diarrhea.

- **Spirillum** (spiral) are gram-negative bacteria that vary from a comma shape to a longer corkscrew shape. Some have flagella (a tail) that enables them to move. An example of spirillum bacteria is *Helicobacter pylori* (*H. pylori*), which uses multiple flagella to propel itself through the mucosal lining and into the stomach. *H. pylori* is one of the causes of stomach ulcers and gastritis.

- The Ziehl-Neilson Stain, also known as acid-fast stain, is another method used to help identify certain bacteria. Microbes that stain red are called acid fast; those that stain blue are non-acid fast. Two of the most common acid-fast bacteria are *Mycobacterium tuberculosis*, which causes tuberculosis (TB), and *Mycobacterium liprae*, which causes leprosy.

Bacteria are also classified by their need for oxygen and are either aerobic or anaerobic. Aerobic bacteria survive and grow in an oxygenated environment. Aerobic bacteria are so abundant that they are the most widely-distributed organism on earth. Common aerobic bacteria include *Staphylococcus*, *Streptococcus* and *C. difficile*.

In contrast, bacteria that don’t need oxygen or may be harmed by oxygen are anaerobic bacteria. These bacteria thrive in the intestinal tract, soil and water. Some anaerobes cause illness, such as appendicitis, diverticulitis and tetanus, and often are responsible for the formation of pus and gas gangrene.

Some bacteria produce spores that are capable of going dormant when conditions become unfavorable for growth. Bacterial spores are bacteria that have formed a tough shell within the cell during a resting stage. This shell protects the bacteria from changes in its environment until environmental conditions return to levels that are favorable for growth. Bacterial spores create many challenges in the healthcare environment because they are difficult to kill and can remain in the environment for years. Most spore-forming microbes are from the *Bacillus* family.

In addition to bacterial organisms, other microbes are responsible for causing disease. These are classified as non-bacterial organisms and include viruses, protozoa and fungi.

- **Viruses**, infectious agents that grow only in living tissue or cells, are about 1,000 times smaller than bacteria and can only be seen with an electron microscope. The Occupational Safety and Health Administration’s Bloodborne Pathogens standard lists two specific viruses of concern: hepatitis B virus (HBV) and acquired immune deficiency syndrome (AIDS). Other viruses of concern are human papilloma virus (HPV), hepatitis C (HCV) and herpes simplex virus (HSV).

- **Protozoa** is a one-celled, animal-like organism. Its size ranges from 18 to 25 microns and it moves by means of blunt pseudopodia (false feet). Protozoa can be found in feces, intestinal ulcers and liver abscesses, and can cause disease, such as Rocky Mountain spotted fever and Lyme disease.

- **Fungi** are a large group of plant-like organisms that include molds, mushrooms and yeasts. Some fungi require use of a microscope to be seen, while others, such as mushrooms, are quite large. Many fungi are useful and necessary for producing bread, cheese, wine and beer. Fungi are also involved in the production of antibiotics, such as penicillin. Illnesses caused by fungi include ringworm, athletes foot and histoplasmosis.

- **Prions** are an infectious agent composed of protein in a misfolded form. Prion disease is currently untreatable and fatal. Creutzfeldt-Jakob Disease (CJD) is a prion disease of special concern to CS technicians, and special processing and sterilization protocols are required to manage devices used on a suspected or confirmed CJD patient.

**OBJECTIVE 4: EXPLAIN THE ENVIRONMENTAL CONDITIONS NECESSARY FOR THE GROWTH, SURVIVAL AND DESTRUCTION OF MICROBES**
The three most important factors in bacterial environments are temperature, moisture and relative humidity. Temperature requirements vary widely among different kinds of bacteria. Psychrophiles prefer cold temperatures and grow best at 59°F to 68°F; while thermophiles generally thrive in warmer temperatures (122°F to 158°F). Mesophiles prefer moderate
temperatures (68°F to 113°F); these bacteria are responsible for causing most human illness as body temperature provides optimum growth conditions. Moisture and relative humidity are also important for the growth and survival of microorganisms. Some bacteria cannot survive in a dry environment and others, such as Mycobacterium tuberculosis, can survive for years in a dry state.

The period of active growth for bacteria is called the vegetative state. This is the time where the organism is actively growing, rather than resting. Sunlight is lethal to the vegetative stage of pathogens.

Because the primary purpose of the CS department is to control the spread of microorganisms, destruction will occur through proper cleaning, disinfection and sterilization of instruments and reusable medical equipment. Understanding the types of microbes and their conditions for survival helps CS technicians become successful in this mission.

**OBJECTIVE 5: DISCUSS THE TRANSMISSION OF MICROORGANISMS IN THE CENTRAL SERVICE DEPARTMENT**

Most microorganisms cannot travel by themselves, but can easily move from place to place by people, animals, air, dust particles, liquids, inanimate objects and surgical instruments. Because many patients in the healthcare setting are already immunocompromised, it is critical for CS technicians to break the chain of infection.

Patients may be compromised by illness, age, injury and/or surgery. Instruments and patient equipment are used over and over again, and, therefore, must be properly processed to eliminate and/or destroy all potentially infectious contaminants that are present. Some microorganisms are more difficult to kill than others and that is one reason why disinfection and sterilization processes are so complex. No single disinfection or sterilization process can kill all microorganisms; however, when performed correctly, thorough cleaning, disinfection and sterilization processes will break the chain of infection.

Safe delivery of reusable and single-use items is also necessary and can be accomplished by the establishment and enforcement of standards for proper handling, storage and distribution of patient care items. Practicing hand hygiene prior to handling clean/sterile items and following appropriate handling techniques will help keep items safe and undamaged. Ensuring items are distributed correctly by not overcrowding carts and practicing safe transportation processes will also help keep items safe for use.

**OBJECTIVE 6: REVIEW BASIC PROCEDURES TO CONTROL AND KILL MICROORGANISMS**

Many policies and procedures must be developed and followed in each stage of the process to stop the spread of infection. Each area of CS must be properly maintained and monitored to help ensure items remain safe. This is accomplished by diligent and consistent adherence to the following standards:

» Environment
  • Keeping the environment clean
  • Maintaining appropriate temperature and humidity requirements, including positive and negative air exchanges
  • Keeping work areas clean
  • Wearing proper attire and personal protective equipment (PPE)
  • Practicing proper hand hygiene
  • Practicing safe handling and disposal of all sharps
  • Ensuring processing equipment is maintained and monitored as recommended by the equipment manufacturer’s instructions for use (IFU)
• Attending all staff training and continuing education sessions

» Soiled transport
• All items received in the decontamination area should be in a transport cart or closed container.
• Avoid transporting solutions that can splash out of their containers.
• Items should be placed within the cart to protect them from falling during transportation.

» Decontamination/Disinfection
• Always wear appropriate PPE for the task being completed.
• Follow the manufacturer’s IFU for proper disassembly of all devices.
• Follow the manufacturer’s IFU for cleaning instruments and reusable medical equipment.
• Follow the manufacturer’s IFU for proper selection, dilution and contact time for disinfectants.

» Sterilization
• Follow the manufacturer’s IFU for the correct method and parameters required for that item or set.
• Do not handle items before they have properly cooled.

» Handling/Storage
• Ensure items are properly cooled prior to storage.
• Use caution when removing/placing sterile items from/to shelves or carts.
• Follow established protocols for stock rotation.

» Distribution
• Practice hand hygiene before handling clean/sterile items.
• Transport sterile items in closed/covered carts/containers.
• Transport items carefully to avoid product damage.

CONCLUSION
The daily work of a Central Service technician is driven by the world of microbiology. The conditions for microbial survival must be considered in each task performed. When standards and protocols are properly adhered to, a CS technicians can break the chain of infection. It is the responsibility of all CS technicians to ensure that microorganisms from one patient are not transferred to another.

RESOURCES


IAHCSMM acknowledges the assistance of the following two CS professionals who reviewed this quiz:

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1. Approximately ___% of microbes are pathogenic.
   a. 2
   b. 5
   c. 10
   d. 15

2. Spherical-shaped bacteria are called:
   a. Spores
   b. Bacillus
   c. Spirillum
   d. Cocci

3. A common acid-fast bacteria is:
   a. \textit{Staphylococcus aureus}
   b. \textit{Mycobacterium tuberculosis}
   c. \textit{Methicillin-resistant staphylococcus aureus}
   d. \textit{Escherichia coli}

4. Microbes that require oxygen to live are called:
   a. Endospores
   b. Anaerobic
   c. Gram negative
   d. Aerobic

5. All bacteria can produce spores when conditions to live become unfavorable.
   a. True
   b. False

6. Spores can be easily destroyed by:
   a. Sterilization
   b. Thorough cleaning
   c. Making the environment favorable to bacteria growth
   d. None of the above

7. Viruses
   a. Are smaller than bacteria
   b. Can only grow in living tissue
   c. Can only be seen using an electron microscope
   d. All the above

8. Prions are gram-positive bacteria that are very difficult to clean.
   a. True
   b. False

9. Most pathogenic bacteria prefer temperatures between:
   a. 68°F to 113°F
   b. 59°F to 68°F
   c. 122°F to 158°F
   d. 70°F to 95°F

10. The stage where bacteria grow is called:
    a. Endospore
    b. Dormant
    c. Vegetative
    d. Active

11. The chain of infection can be broken by:
    a. Following the manufacturer’s instructions for use
    b. Following departmental policies and procedures
    c. Properly cleaning, disinfecting and sterilizing each item
    d. All the above

12. A key component of infection prevention is:
    a. Patient age
    b. Understanding psychrophiles
    c. Breaking the chain of infection
    d. All the above

13. The chain of infection can be broken by:
    a. Controlling thermophiles
    b. Immunization against Methicillin-resistant \textit{Staphylococcus aureus}
    c. Following proper cleaning and sterilization processes
    d. All the above

14. Stock rotation and hand hygiene are important components of the distribution process.
    a. True
    b. False

15. Wearing appropriate personal protective equipment in one step in controlling microorganisms.
    a. True
    b. False

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