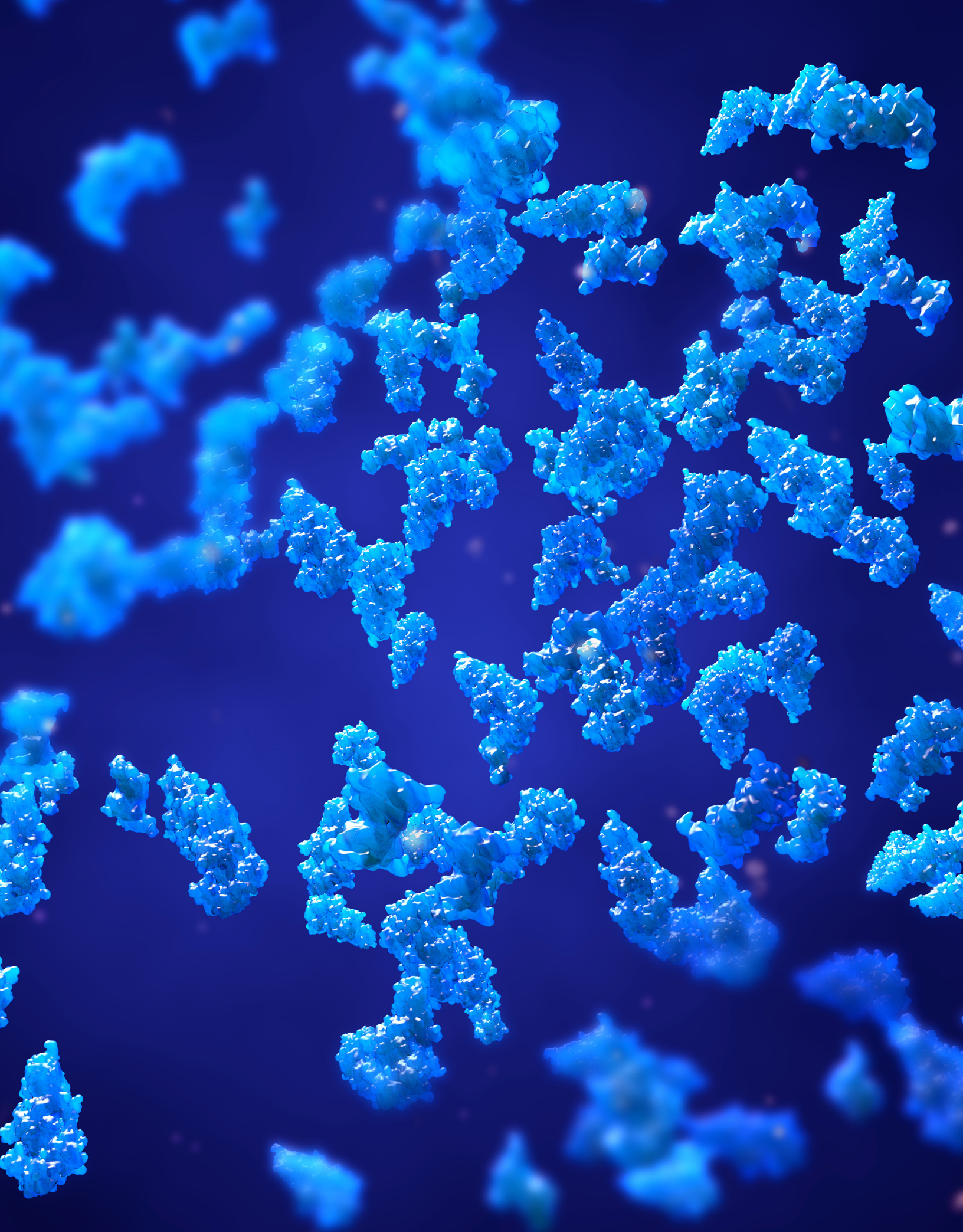

CIS SELF-STUDY LESSON PLAN

Lesson No. CIS 285 (Instrument Continuing Education - ICE)

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Biological Macromolecules and Enzymatic Detergents

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LEARNING OBJECTIVES

1. Discuss biological mechanisms and chemical reactants
2. Explain detergents and the environmental factors that affect them
3. Review quality measures to test the effectiveness of detergents

Healthcare surgical instrument inventory consists of a variety of tools, each accompanied with its own complexity and delicateness. Even instrumentation that appears simplistic can provide reprocessing challenges. Examples of common problematic areas of instrumentation include (and are not limited to) grooves, teeth, channels, hidden gaps, and lumens. Bioburden accumulating on surgical instrumentation is an inevitable aspect of reprocessing instrumentation that Sterile Processing (SP) professionals must account for. Microbes on a soiled surgical instrument can increase exponentially within minutes following the medical procedure; therefore, it is appropriate that proper precautions are taken to provide effective cleaning solutions—and to ensure that methods are used that are capable of reducing bioburden and bacterial growth prior to sterilization. Detergents play a major role and are a very influential part of point-of-use care and decontamination processes.

Objective 1: Discuss biological mechanisms and chemical reactants

The cleaning process for surgical instrumentation must begin during the procedure at the point of use. Soiled instrumentation should be separated from unused instruments and be kept moist with an approved enzymatic detergent or moisturizing chemical. Soiled medical instrumentation should not be allowed to dry; debris that dries makes the instrument much more difficult to clean. Blood is always considered the enemy in sterile processing. It is highly recommended to keep blood and protein substances from drying by using an enzymatic detergent, moisturizing agent, or wet towel.

It is important to cover aspects of biological molecular structures that bond together—and to understand the functionality of each when performing SP cleaning duties. An understanding of these properties will greatly improve how SP professionals understand how detergents remove bioburden and why certain standards must be followed to allow maximum effectiveness. Biologically, blood has many unique

chemical properties that allow the body to function, and it has these properties because of macromolecules. A macromolecule can be defined as a large molecule composed of smaller biological subunits called monomers. It is through these chemical interactions that life can exist and respond to environmental conditions (both internal and external). These macromolecules are the basis of life and are found in all humans.

SP professionals should be familiar with the following classes of biological macromolecules: lipids, carbohydrates and proteins. Carbohydrates, lipids and proteins exist everywhere in body. Therefore, these biological macromolecules will appear quite often on soiled instrumentation and must be removed.

Poor removal of these macromolecules can cause an irregular appearance that will make the cleaning process more difficult, or it could potentially destroy the instrument. Pitting can result from long-term exposure to dried blood. If pitting occurs on an instrument, the instrument should be removed from service (pitted instruments typically cannot be repaired). If an instrument presents with a yellow/brown discoloration, protein residue could be the cause. Proteins are commonly found in bodily fluids and are known for adhering to an instrument's surface. As a result, the protein will react with the instrument's metal passivation layer and start to break the layer down (this causes the yellow/brown discoloration). Lipids will cause an instrument to become greasy, making the cleaning process much more difficult by preventing the detergent from making contact with the surgical instrumentation. Also, large amounts of grease in the water could contaminate other surgical instrumentation. *When sink water appears cloudy and greasy, it is extremely important to drain and clean the sink thoroughly before refilling with clean water.*

The rate of bacterial reproduction may increase if large amounts of carbohydrates are present. Carbohydrates (such as sugars, starches and fiber) serve as a vital food source for bacteria in the human body. SP professionals should be aware that surgical procedures involving the human digestive system must be handled very carefully. It is possible for surgical instrumentation used for these procedures to carry larger amounts of bacteria and biofilm due (in part) to the increased amount of carbohydrates present. To prevent this, SP professionals should use an enzymatic detergent or moisturizing spray on soiled instruments. Again, it is essential to ensure proper cleaning at the point of use.

Objective 2: Explain detergents and the environmental factors that affect them

Enzymatic detergents are formulated with proteins called enzymes and are designed to lift gross soil from medical instruments. Enzymes are highly specific, meaning they will only break down macromolecules with which they are compatible. For example, protease enzymes will only target proteins, while amylase breaks down carbohydrates, and lipase will only react with fats. Because macromolecules are found throughout the body, enzymatic detergents are essential for help remove bioburden on instruments. Enzymatic stabilizers are added to enzymatic detergents to help the enzyme last longer. This is especially important in storage because the stabilizers greatly help each enzyme maintain its cleaning properties for lengthy periods of time.

Sequestering and chelating agents (non-enzymes) are other properties found in the detergent. These agents assist in the cleaning process by binding and keeping soil from returning to the instruments during the cleaning process; they are suitable for dealing with heavy metals and ions in blood and other bodily fluids. Newer detergent products can be formulated with strictly sequestering and chelating agents. The sequestering and chelating agents attack bioburden by removing (without enzymes) the bioburden from the surgical instruments. There are many benefits to a non-enzymatic detergent. These benefits include:

- The cleaning solution not relying on a minimum contact time;
- No temperature restrictions; and
- A longer usage of the detergent without draining the water in the sink.

It's important to note that instruments that can only be temporarily submerged will have a difficult time being cleaned properly since it would not meet the enzymatic detergent's minimum exposure time. Non-enzymatic detergents can be used as a surfactant that does not require a minimum exposure time; however, a non-enzymatic detergent would require the SP professional to use more effort by brushing and targeting problematic areas to remove bioburden. Using a non-enzymatic detergent may work well in short-term situations when the SP professional can clean it promptly, but these detergents will not break down the bioburden on instruments over time (instead, they attach to the bioburden on the surgical instrument and dry). Enzymatic detergents, on the other hand, begin to break down bioburden and biofilm, which allows for easier cleaning.

In order for enzymes to be effective, they must be kept within the optimal range. If the enzyme is not within the optimal range, there is a risk of the protein becoming denatured. These parameters (water temperature, pH level, proper storage, and correct

dosage administration during the washer-disinfector cycles) play a critical factor in the cleaning process and in preserving medical instrumentation. Proper water temperature in the sink for the enzymatic detergent should be between 90-110°F. This range provides a suitable environment for the enzymes to facilitate the breakdown of bioburden. If the water is too hot (above 110°F), proteins will begin to coagulate and the water will begin to appear cloudy. If the water is too cold (below 90°F), the enzyme will be deactivated and will not be effective at removing biological debris.

Most enzymatic detergents are formulated to operate best at a neutral-pH level (pH ~7). SP professionals should be aware of the buildup of gross soils within the sink. The breakdown of macromolecules could change the pH of the solution. Regardless of whether the pH is increased or decreased, the change from a neutral pH will denature all enzymes in the detergent, causing the enzymatic to become less effective.

Objective 3: Review quality measures to test the effectiveness of detergents

Challenging the cleaning process should be a daily process. This ensures that equipment and enzymatic detergents are being administered and are working properly. To ensure that enzymes are working at optimal efficiency, washer-disinfector settings and proper detergent dosage must also be taken into account. The type of washing setting, duration of time for cycles, amount of detergent, and temperature should be calibrated according to the instructions for use of the enzymatic detergents. The role of the SP professional consists of daily testing of the washer-disinfector to ensure it is working according to the manufacturer's specifications. A method of verification includes a washer-disinfector cleaning monitoring test. This monitoring test simulates a bloody instrument and challenges the cleaning effectiveness of the enzymatic and impingement of the washer-disinfector. A successful test would demonstrate that the testing medium is removed from the strip.

SP professionals should check daily to ensure mechanical processes have enough enzymatic detergent (and that it is properly concentrated). Improper storage of enzymatic detergents can also hinder the cleaning process. It is important to avoid storing enzymatic detergents in areas that have direct sunlight, high heat, extreme cold and high humidity—all conditions that will disable or denature the enzymes.

Conclusion

It is important to address challenges that prevent detergents from being effective—and to understand how enzymatic detergent components work. An effective cleaning process begins with point of-use care and incorporates an enzyme, moisturizing agent or moistened towel to prevent blood from drying and biofilm from forming. If a surgical instrument is exposed to macromolecules for a lengthy period of time, that bioburden can damage the instrumentation by reacting with the metal and causing discoloration and/or pitting.

Enzymatic detergents play an important role in the cleaning process; therefore, it is necessary to ensure the detergents are kept in an optimal range, and to adhere to the IFU and test equipment properly, so instruments can be properly cleaned and remain functional for use in patient care.

RESOURCES

1. www.canmedhealthcare.com/parent/Technical_Bulletin_Enzmatic_Detergents.pdf
2. www.cdc.gov/infectioncontrol/guidelines/disinfection/cleaning.html
3. www.hpnonline.com/sterile-processing/article/13001537/keeping-murphys-law-out-of-the-spd
4. www.infectioncontroltoday.com/view/spotting-staining-and-corrosion-surgical-instruments
5. www.steris.com/healthcare/products/surgical-instrument-cleaning-chemistries
6. www.stryker.com/us/en/orthopaedic-instruments/products/blu62-pretreatment-foam-and-instrument-detergent.html

CIS Self-Study Lesson Plan Quiz - Biological Macromolecules and Enzymatic Detergents

Lesson No. CIS 285 (Instrument Continuing Education - ICE) • Lesson expires May 2024

1. Which enzyme or agent is responsible for breaking down protein in blood?
   a. Protease
   b. Lipase
   c. Sequestering and chelating agents
   d. Amylase

2. Pitting results from which of the following?
   a. Improper storage of enzymatic detergent
   b. Adding an enzyme to water temperature above 110°F
   c. Sequestering and chelating agents being exposed to colder temperatures
   d. Repeated exposure to dried blood

3. What is the correct temperature range for an enzymatic detergent?
   a. 80-110°F
   b. 100-120°F
   c. 90-110°F
   d. 90-120°F

4. Which treatment should be used on instruments at the point of use?
   a. An enzyme/surfactant 10-minute soak
   b. A detergent soak
   c. Use of a low-level disinfectant
   d. Use of an enzymatic/moisturizing spray

5. What is a macromolecule?
   a. Several molecules of the same type that have attached to one another
   b. A large molecule composed of smaller monomers
   c. Macro-atoms combined together
   d. A combination of lipids and proteins

6. Which is an example of a macromolecule?
   a. Lipids or carbohydrates
   b. Blood serum
   c. Surfactants
   d. Enzyme stabilizers

7. A yellow/brown stain on instruments could be caused by:
   a. Fat residual that has been exposed to heat
   b. Lipids
   c. Protein reacting with the instrument's passivation layer
   d. Increased bacterial reproduction caused by carbohydrate residuals

8. Stabilizers are used to:
   a. Help bind and stabilize bioburden on the instrument
   b. Attack bioburden
   c. Stabilize the cleaning solution at higher temperatures
   d. Help enzymes maintain their cleaning properties longer

9. Sequestering and chelating agents:
   a. Can be used with enzymes to clean instruments
   b. Remove bioburden with less manual effort
   c. Are incompatible with enzymes
   d. Can remove proteins and lipids but not carbohydrates

10. Enzymes work best in:
    a. High pH
    b. Low pH
    c. Cold water
    d. Neutral pH

11. Washer-disinfectors should be tested:
    a. Daily to ensure the cleaning solution and equipment are working properly
    b. Weekly to ensure the cleaning solution and equipment are working properly
    c. Daily to test point-of-use care efficiency
    d. At the end of each shift

12. Enzymatic detergents can become denatured or disabled if stored in direct sunlight, high heat, extreme cold and/or high humidity.
    a. True
    b. False

13. The amount of detergent used in a washer cycle should be calibrated to:
    a. The instrument manufacturer's instructions for use
    b. The detergent manufacturer's instructions for use
    c. The types of devices being cleaned in each cycle
    d. The length of the washer cycle

14. Heavy metals in blood can be cleaned from devices using:
    a. Sequestering and chelating agents
    b. Enzymes with a high pH
    c. A moisturizing agent
    d. All the above

15. Enzymes used in a higher-than-recommended temperature range:
    a. Will cause bioburden to become affixed to the instrument and be unable to be removed
    b. Are acceptable if left in hot water for a brief period of time
    c. Allow proteins to coagulate
    d. None of the above

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