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Learning Objectives
Lesson 18.1: Introduction to Microbiology

1. Pronounce, define, and spell the key terms.
2. Explain why the study of microbiology is important for the dental assistant.
3. Discuss the contributions of early pioneers in microbiology.
4. List the four criteria of Koch’s postulates.

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Learning Objectives
Lesson 18.1: Introduction to Microbiology (Cont.)

5. Identify and explain the five major groups of microorganisms, including the following:
   - Identify the three basic types of bacteria according to their shape.
   - Explain the Gram’s stain classification system used to identify bacteria.
   - Describe the differences among aerobes, anaerobes, and facultative anaerobes.
   - Identify the most resistant form of life known, and explain how it survives.
   - Describe how prions differ from viruses and bacteria and name two diseases caused by prions.
   - Compare viruses with bacteria, and name diseases caused by each.
   - Explain why specificity in viruses is important.
Introduction

- Microbiology: The study of microorganisms
  - Micro means “microscopically small,” and bio means “living organisms”
- The dental assistant needs a foundation in microbiology to understand the nature of pathogens and how to prevent the transmission of disease in the dental office
- The two major oral diseases are bacterial infections:
  - Dental caries (decay)
  - Periodontitis

Pioneers in Microbiology

- Aristotle (384–322 BC): Believed that life arose from muck, decaying food, warm rain, or even dirty shirts
- Antony van Leeuwenhoek (1632–1723): Used a primitive microscope to observe stagnant water, hay infusions, and scrapings from the teeth
- John Tyndall (1820–1893): Discovered that some bacteria existed in two forms: a heat-stable form and a heat-sensitive form
- Joseph Lister (1827–1912): Was the first to recognize the role of airborne microorganisms in postsurgical infections

Pioneers in Microbiology (Cont.)

- Robert Koch (1843–1910): Developed a two-part dish for growing bacteria and a technique for isolating pure colonies of bacteria
- Julius Petri (1852–1921): Petri plates, dishes used to isolate bacterial colonies, were named after him
- Louis Pasteur (1822–1895): “Father of microbiology,” developed the process of pasteurization and discovered the first vaccine for rabies
Petri Plate

Koch’s Postulates
- The microbial agent must be found in every case of the disease
- The microorganism must be isolated and grown in pure culture
- The microorganism must cause the same disease when inoculated into a susceptible animal
- The same microbial agent must be recovered from the inoculated animal

Rabies Vaccine

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Louis Pasteur

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Major Groups of Microorganisms
- Bacteria
- Rickettsiae
- Algae
- Protozoa
- Fungi
- Prions
- Viruses

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Bacteria
- A large group of one-celled microorganisms that vary in shape, size, and arrangement
- Pathogenic bacteria usually grow best at 98.6°F (37°C) in a moist, dark environment
- Skin, respiratory tract, and gastrointestinal tract are inhabited by a great variety of harmless bacteria, called the normal flora
- Infection occurs when bacteria occurring naturally in one part of the body invade another part of the body and become harmful
Shapes of Bacteria

- Spherical (coccus, plural cocci)
  - Reproduces by dividing in two
  - Cocci that form chains as they divide are called streptococci
  - Cocci that form irregular groups or clusters are called staphylococci
- Rod-shaped (bacillus, plural bacilli)
- Spiral (spirillum, plural spirilla)

Three Basic Shapes of Bacteria

Colonies of Streptococci
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Colonies of Staphylococci

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Gram-Positive and Gram-Negative Bacteria

- Hans Christian Gram (1853–1938) developed a four-step staining process for separating bacteria into two groups
- Gram staining requires the sequential use of a crystal violet dye, iodine solution, alcohol solution, and a safranin dye
- The bacteria that are stained by the dye are classified as Gram positive (they appear dark purple under the microscope)
- The bacteria that are not consistently stained are classified as Gram variable (e.g., Mycobacterium tuberculosis)

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Gram-Positive Stain

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Gram-Negative Stain

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Need for Oxygen
- Aerobes
  - A variety of bacteria that require oxygen to grow
- Anaerobes
  - Bacteria that grow in the absence of oxygen and are destroyed by oxygen
- Facultative anaerobes
  - Organisms that can grow in the presence or the absence of oxygen

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Capsules
- Some types of bacteria form a capsule or protective layer that covers the cell wall (e.g., Streptococcus mutans)
  - Generally virulent (capable of causing serious disease)
  - Capsule increases the bacteria’s ability to resist the defense mechanisms of the body
  - Capsule may also prevent antibiotic agents from having an effect on the bacteria
Spores

- Some bacteria change into a highly resistant form called spores
  - Bacteria remain alive in the spore form but are inactive
- Spores represent the most resistant form of life known
- Can survive extremes of heat and dryness and even the presence of disinfectants and radiation
- Harmless spores are used to test the effectiveness of the techniques for sterilizing dental instruments

Rickettsiae

- Short, nonmovable rods that normally live in the intestinal tract of insects such as lice, fleas, ticks, and mosquitoes
- Very small and require host cells to reproduce
- Diseases caused by rickettsiae include typhus and Rocky Mountain spotted fever
  - Transmitted to humans by way of the bite of an infected insect

Algae

- Algae range from microscopic single-cell organisms to larger multiple-cell organisms such as seaweed and kelp
- All algae contain chlorophyll, as well as pigments that cause them to appear yellow-green, brown, or red
- Algae are found in abundance in both freshwater and marine habitats
- Most algae do not produce human disease
Protozoa

- A large group of single-cell organisms
- Some can remain viable as cysts for long periods outside their hosts
- Most do not cause disease, but some live in hosts and do cause damage
- A small number of protozoa are responsible for intestinal infections in human beings; others invade the blood, lungs, liver, or brain

Fungi

- Fungi are plants, such as mushrooms, yeasts, and molds that lack chlorophyll
- Candida is a common yeast found in the oral cavity of about half of the population
- It also is found in the gastrointestinal tract, female genital tract, and sometimes the skin
- Cross-infection may occur between mother and baby or among infant siblings

Oral Candidiasis

- Caused by the yeast Candida albicans
- All forms of candidiasis are considered opportunistic infections: they are found in patients who are very young, very old, or very ill
- Characterized by white membranes on the surface of the oral mucosa, tongue, and elsewhere in the oral cavity
- Lesions may look like thin cottage cheese and can be wiped off to reveal a raw, red, and sometimes bleeding base
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Examples of Oral Candidiasis

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Prions

- Small proteinaceous infectious particles
- They are composed entirely of proteins that lack nucleic acids (DNA or RNA)
- Until the discovery of prions, it was believed that any agent capable of transmitting disease had to be made up of genetic material composed of nucleic acids
- Prions convert normal protein molecules into dangerous ones simply by causing the normal ones to change their shape
- Prions are a new and separate class, unlike bacteria, fungi, viruses, and all other known pathogens

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Prion Diseases

- “Mad cow” disease
- Linked to human diseases such as Creutzfeldt-Jacob disease (a rare form of dementia) and possibly Alzheimer’s disease
- Prion-caused diseases have been found in human beings and animals
- Highly resistant to heat, chemical agents, and irradiation
- No treatment or vaccine against prion diseases, and the only preventive measure is not eating suspect food
Future Research on Prions

- Ongoing research to determine whether prions that consist of other proteins play a part in more common neurodegenerative conditions such as Alzheimer’s disease, Parkinson’s disease, and amyotrophic lateral sclerosis.
  - These three disorders have marked similarities.
  - As with all prion diseases, these neuropathologic diseases occur sporadically but sometimes run in families.

Viruses

- Much smaller than bacteria.
- Despite their size, many viruses cause fatal diseases.
- New and increasingly destructive viruses are being discovered and have caused the creation of a special area within microbiology called virology.
- Viruses can live and multiply only inside an appropriate host cell.
- A virus invades a host cell, replicates (produces copies of itself), and then destroys the host cell so that the viruses are released into the body.

Virus Specificity

- Viruses can exhibit specificity (preference) for particular cell types in which to replicate.
- Some other viruses are able to cause disease in more than one organ.
- Some viruses can cross the placenta and infect the fetus.
Slide 34: Virus Latency
- Some viruses establish a latent (dormant) state in host cells
- A latent virus can be reactivated in the future and produce more infective viral particles, followed by signs and symptoms of the disease
- Stress, another viral infection, and exposure to ultraviolet light can reactivate the virus
- HIV has a latency period of months to years
- Hepatitis C is known to have a latency period of 15 to 25 years

Slide 35: Treatment of Viral Diseases
- Viruses cause many clinically significant diseases in human beings
- General antibiotics are ineffective in preventing or curtailing viral infections, and even the few drugs that are effective against some specific viruses have limitations
- Viruses are also capable of mutation
- It is very difficult to develop vaccines against viruses because of the ability of viruses to change their genetic code

Slide 36: Transmission of Viral Diseases
- Viral diseases are transmitted by:
  - Direct contact
  - Insects
  - Blood transfusions
  - Contaminated food or water
  - Inhalation of droplets expelled by coughing or sneezing
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Viruses in the Environment

- Viruses are easily destroyed in the external environment
- Chemicals such as chlorine (bleach), iodine, phenol, and formaldehyde easily and effectively destroy viruses on surfaces and objects
- These agents, however, are too toxic to be used internally

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Learning Objectives
Lesson 18.2: Diseases Caused by Microorganisms

6. Discuss viral diseases, including the following:
   - Identify five types of viral hepatitis and explain how each one is transmitted.
   - Identify methods of HIV transmission and explain the effect of HIV on the human body.
   - Explain the difference between the five types of herpes virus, including type 1 and type 2 herpes simplex virus.
   - Describe the symptoms of an infection of West Nile virus.
   - Describe the symptoms of influenza and how it is spread.

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Learning Objectives
Lesson 18.2: Diseases Caused by Microorganisms (Cont.)

7. Discuss bacterial diseases, including the following:
   - Name the disease that is the leading cause of death from infectious diseases worldwide.
   - Identify the bacterium discovered during an American Legion convention and explain its mode of transmission.
   - Explain how tetanus can be prevented.
   - Describe the three stages of syphilis.
   - Identify the method of transmission of methicillin-resistant Staphylococcus aureus (MRSA) and explain the best methods to prevent its spread.
   - Describe the possible effects of a pandemic disease.
Viral Diseases

- There are at least five types of viral hepatitis, each of which is caused by a different virus:
  - Hepatitis A virus (HAV)
  - Hepatitis B virus (HBV)
  - Hepatitis C virus (HCV)
  - Hepatitis D virus (HDV)
  - Hepatitis E virus (HEV)

Hepatitis A (HAV)

- Can affect anyone
- Spread from person to person when something is put in the mouth that has been contaminated with the stool of a person with hepatitis A (fecal-oral transmission)
- Good personal hygiene and proper sanitation can also help prevent hepatitis A
- Always wash your hands after changing a diaper or using the bathroom
- The least serious form of viral hepatitis
- A vaccine is available that provides long-term prevention in persons older than 2 years

Hepatitis B (HBV)

- A very serious disease that may result in prolonged illness, liver cancer, cirrhosis of the liver, liver failure, and even death
- Bloodborne disease that may also be transmitted by other body fluids, including saliva
- Anyone who has ever had the disease, and some persons who have been exposed but have not been actually ill, may be carriers of HBV and may actually be spreading the infection to others
- This presents a high risk for dental personnel because dental treatment brings them into contact with saliva and blood
### Hepatitis B Immunization

- Highly effective vaccine is available to prevent hepatitis B.
- All dental personnel with a chance of occupational exposure should be vaccinated against hepatitis B.
- The OSHA Bloodborne Pathogen Standard requires that the employer offer the hepatitis B vaccination, at no cost to the employee, within 10 days of initial assignment to a position in which there is chance of occupational exposure to blood or other body fluids.
- The employee has the right to refuse the offer of vaccination; however, that employee must sign a release form indicating that the employer did offer the vaccine and that the employee understands the potential risks of contracting hepatitis B.

### Hepatitis C (HCV)

- Most efficiently transmitted through blood transfusion or percutaneous exposure to blood.
  - Can occur as a result of an accidental needle stick injury to an employee in a dental office, through the sharing of contaminated needles among users of injection drugs, or through use of contaminated tattoo needles.
- The carrier rate for HCV is higher than that of HBV.
- No vaccine against hepatitis C at this time, nor is there a cure for the disease.
- Treatments available to control effects of the disease.
- CDC guidelines now recommend a one-time HCV screening for all baby boomers.

### Hepatitis D (HDV)

- A defective virus that cannot replicate itself without the presence of HBV.
- Therefore, infection with HDV may occur simultaneously as a coinfection with HBV or may occur in an HBV carrier.
- Persons with a coinfection of HBV and HDV often have more severe acute disease and a higher risk of death than do those infected with HBV alone.
- Vaccination against HBV also prevents infection with HDV.
Hepatitis E (HEV)
- Not transmitted through bloodborne contact
- Most frequently transmitted by way of the fecal-oral routes through contaminated food or water
- HEV is most frequently seen in the form of an epidemic in developing countries
- Transmission is not a major concern in a standard dental setting

Human Immunodeficiency Virus
- HIV is a bloodborne viral disease
- An infection in which the body’s immune system breaks down; AIDS is caused by HIV
- When HIV enters the body, it infects special T cells and slowly kills them
- As more and more of the T cells die, the body’s ability to fight the infection weakens
- A person with HIV infection may remain healthy for many years
- AIDS is considered to develop in an HIV-positive person when he or she becomes sick with serious illnesses and infections that can occur with HIV

Human Immunodeficiency Virus (Cont.)
- HIV is spread by sexual contact with an infected person and through needle sharing among drug users
  - Now that blood is screened for HIV antibodies, the blood supply in this country is safe
- Babies born to HIV-infected mothers may become infected before or during birth or, after birth, while breastfeeding
- In (nondental) healthcare settings, workers have been infected with HIV after being stuck with needles containing HIV-infected blood
Herpes Simplex Virus Type 1

- A viral infection that causes recurrent sores on the lips
- Because these sores frequently develop when the patient has a cold or fever of other origin, the lesions have become commonly known as fever blisters or cold sores

Primary Herpes

- This disease, which is highly contagious, makes its first appearance in very young children (1 to 3 years of age) and is known as primary herpes
- Child may have a slight fever, pain in the mouth, increased salivation, bad breath, and a general feeling of illness
  - Inside of mouth becomes swollen, gingivae are inflamed
- Healing begins naturally within 3 days, and the illness is usually over in 7 to 14 days
- Supportive measures can be taken to make the child more comfortable, relieve the pain, and prevent secondary infection
Recurrent Herpes Labialis

- After the initial childhood infection, the HSV lies dormant and reappears later in life as the familiar recurring fever blister or cold sore.
- Recurrences tend to take place when patient's general resistance is lowered due to stress, fever, illness, injury, or exposure to the sun.
- The use of sunscreen with a sun protective factor of 15 helps to prevent sun-induced recurrences of herpes.
- Attacks may recur as infrequently as once a year or as often as weekly or even daily.

Herpes Labialis

Herpes Simplex Virus Type 2

- Genital herpes is one of the most common sexually transmitted diseases in the US.
- Initial symptoms (generally appear 2 to 10 days after infection) tingling, itching, and a burning sensation during urination.
- Once a person is infected with the virus, outbreaks will recur.
- Disease can be transmitted only during recurrences.
- A mother with active vaginal or cervical herpetic lesions at the time of delivery can pass the virus to her newborn.
Other Herpes Viruses

- Herpes zoster virus
  - Causes both varicella (chickenpox) and herpes zoster (shingles)
  - Chickenpox is the primary infection, and zoster represents reactivation of the illness
- Cytomegalovirus
  - Can affect the fetus during pregnancy
- Epstein-Barr virus
  - Responsible for infectious mononucleosis, nasopharyngeal carcinoma, lymphoma, and oral hairy leukoplakia

Herpes Transmission

- Major transmission route for herpesvirus is through direct contact with lesions
- Even when there are no active lesions, there is still the possibility of transmission of the virus through saliva or aerosol spray from the dental handpiece
- Because there is no preventive vaccine against herpes, it is essential that precautions be taken to prevent exposure
- Protective eyewear is important because a herpes infection in the eye may cause blindness
- Gloves protect against infection through lesions or abrasions on the hands

West Nile Virus

- West Nile virus (WNV) is commonly found in Africa, West Asia, and the Middle East
- Has likely been in the US since early summer of 1999
- Virus carried by mosquitoes; can infect human beings, birds, horses, and some other mammals
- Affects a person’s nervous system, causing inflammation of the brain and spinal cord
- Symptoms include fever, headache, tiredness, aches, and sometimes rash
  - Occurs primarily in the late summer or early fall
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H1N1 Flu Virus (Swine Flu)
- Not related to previous or current human seasonal influenza viruses
- The new H1N1 virus spreads very easily from person to person
- The most effective way to protect yourself is to receive the vaccine and practice meticulous hand hygiene
- For additional resources, go to www.osap.org.

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Ebola Virus
- Rare but often deadly virus
- Causes bleeding inside and outside of the body
- First occurred in 1976
- Disease kills up to 90% of people who are affected
- Spread through direct contact with blood and body fluids
- A person infected with Ebola is not considered contagious until symptoms appear

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Guidelines for Dental Professionals on the Ebola Virus
- Highly unlikely someone with Ebola will seek dental care when they are severely ill
- CDC and ADA Division of Science advise dental professionals to take a medical history, including a travel history, from their patients
- Any patient within 21 days of returning from West African countries may be at risk
  - Dental professionals are advised to delay routine dental care until 21 days have elapsed from their trip
Zika Virus
- Spread to people primarily through the bite of an infected mosquito
- Most common symptoms include fever, rash, joint pain, and conjunctivitis
- People do not usually get sick enough to go to the hospital; very rarely die
- Can be spread from pregnant woman to fetus, which has been linked to a serious birth defect called microcephaly

Bacterial Diseases
- Tuberculosis
- Legionnaires’ disease
- Tetanus
- Syphilis
- Methicillin-resistant Staphylococcus aureus (MRSA)

Tuberculosis
- Caused by the bacterium Mycobacterium tuberculosis
- Leading cause of death resulting from infectious disease worldwide
- HIV and tuberculosis are often present together
  - Of the two diseases, tuberculosis is a greater health risk for healthcare workers
- “Tuberculosis kill time” is the benchmark for the effectiveness of a surface disinfectant
Légionnaires’ Disease

- Legionella pneumophila causes two acute bacterial diseases:
  - Pontiac fever
  - Légionnaires’ disease
- Bacteria are transmitted through aerosolization and aspiration of contaminated water
- No person-to-person transmission
- Dental personnel have higher titers of antibodies against L. pneumophila than do members of the general public

Tetanus

- Also known as lockjaw
- An extremely dangerous and often fatal disease caused by a spore-forming bacillus found in soil, dust, or animal or human feces
- This microbe is usually introduced into the body through a wound or break in the skin (e.g., a puncture wound caused by a soiled instrument)
- The disease can be prevented by the administration of a vaccine; however, immunity must be kept current through booster doses
Syphilis

- A sexually transmitted disease (STD) caused by Treponema pallidum spirochetes
- Bacteria are quite fragile outside the body, but can cross-infect the dental operator through contact with oral lesions
- First stage of syphilis is a painless ulcerating sore, known as a chancre, which is infectious on contact
- Second stage is also infectious; immediate infection may occur as a result of contact with an open sore
- The third stage, known as latent syphilis, is usually fatal, and it may occur after the disease has been dormant for 20 years

Examples of Syphilis


Methicillin-Resistant Staphylococcus aureus (MRSA)

- A bacteria that is resistant to some antibiotics
- This type of Staphylococcus aureus has evolved due to the excessive use of penicillin antibiotics over the years
- MRSA infections can be on the surface of the skin or can go into the soft tissue and form a boil or an abscess
Prevention Tips for MRSA

- Always maintain good hand hygiene practices
- Never squeeze or try to drain any sore
- Keep any wound covered until it has healed
- Do not share personal items such as towels, razors, sheets, clothes

Pandemic Diseases

- A global disease outbreak
- A pandemic occurs when a new virus or disease emerges for which people have little or no immunity, and for which no vaccine is available
- In addition to illness and death, an especially severe influenza pandemic may cause severe disruption resulting from school and business closings and interruption of public transportation and food services

Questions?