MODEL LESSON

TOPIC: BACTERIA

SUBJECT: Biology

LEVEL/AGE: 7- 9 grade/13 -15 age

FOREKNOWLEDGE: Basic from science lessons in previous grades

CORRELATION: Structure and Function of Living organisms, Cells and Organisation, Nutrition and digestion, Genetics and Evolution

TIME: 60 min

KEY WORDS

- Bacteria
- Cell
- Pili
- Cytoplasm
- DNA/Chromosome
- Flagella
- Microbe
- Microscope
- RNA

LEARNING OUTCOMES

All students:

- Will know that there are different types of bacteria.
- Will be able to describe the characteristics of bacteria
- Will know that they are found everywhere.

More able students:

- Will explain how bacteria contribute to life on Earth
- Will know that useful bacteria are found in our body.

TEACHING METHODS

- This biology lesson is structured to follow the 5E Constructivists Model: engage, explore, explain, extend, and evaluate

RESOURCES

- SH 1 - brief info about bacteria
- SH 2 – laminated images of a bacteria
- SH 3 – detailed bacteria notes
- Worksheet
- Modelling clay
- String
- Wooden or plastic beads
- Cling wrap
- Tooth picks – cut in tiny pieces
- A variety of images
- Animations to demonstrate the differences in bacterial size and shape
- videos

ACTIVITIES

INTRODUCTION TO THE LESSON (5 MINUTES)

Introductory video: https://edpuzzle.com/media/604e7b40a9978d4258babe08

Essential question: How does bacteria contribute to life on Earth?

Explaining the objectives of the lesson.

Let's engage!

This lesson begins by polling students on whether or not they have dealt with prior infections. These activities hook students into a conversation about bacteria. Poll questions: Have you ever had a strep throat infection? Have you ever had a pink eye infection? Have you ever had an ear infection? Have you ever had food poisoning?

What else do you know about bacteria?

THEORY PART (3 MINUTES)

Students read/listen to the teacher/ about bacteria.

Example1: Bacteria are single celled organisms that can multiply exponentially, on average once every 20 minutes. During their normal growth, some produce substances (toxins) which are extremely harmful to humans and cause disease (Staphylococcus aureus). Some bacteria are completely harmless to humans whereas others are extremely useful to us (Lactobacillus in the food industry) and even necessary for human life such as those involved in plant growth (Rhizobacterium). Harmless bacteria are called non-pathogenic, while harmful bacteria are known as pathogenic. Over 70% of bacteria are non-pathogenic (harmless) micro-organisms.

Bacteria can be simply divided into three groups by their shapes – cocci (balls), bacilli (rods) and spirals. Cocci can also be broken down into three groups based on how the cocci are arranged: staphylococci (clusters), streptococci (chains) and diplococci (pairs). Scientists use these shapes to tell which infection a patient has.

As living creatures, microbes have certain growth requirements but these vary depending on where the microbe is found. For example, microbes which live in humans prefer a temperature of 37oC, microbes living in deep sea thermal vents prefer much higher temperatures whereas microbes living in arctic regions prefer much lower temperatures. Microbes also vary in their nutrient requirements. A change in the environment can kill many microbes although it is important to remember that microbes are extremely adaptable and gradual changes can result in microbes adapting to suit their environment e.g. antibiotic resistant bacteria.

Example2: Bacterial Cell

Hundreds of thousands of bacterial species exist on Earth. They can be found in very diverse environments ranging from cold to hot and alkaline to acid. They live in soil, in water, and on rocks. They exist deep in the earth, high on mountains, and in deep-sea vents. They grow on and in other bacteria, worms, insects, plants, animals, and people.

Bacteria are prokaryotes . Prokaryotic cells possess simpler structures than eukaryotic cells , since they do not have a nucleus , other membrane bound organelles , or a cytoskeleton . Bacterial cells have two major compartments, the cytoplasm and cell envelope, and may also have exterior appendages , such as flagella or pili. There are two major types of prokaryotes: bacteria and archaea. Archaea (also called archaebacteria) are often found in extreme environments, and while they are clearly prokaryotic, they have evolved separately from bacteria.

Growth and Reproduction

Bacterial cells grow by a process called binary fission: One cell doubles in size and splits in half to produce two identical daughter cells. These daughter cells can then double in size again to produce four sibling cells and these to produce eight, and so on. The time it takes for a bacterial cell to grow and divide in two is called the doubling time. When nutrients are plentiful, the doubling time of some bacterial species can be as short as twenty minutes. However, most bacterial species show a doubling time between one and four hours. A single bacterial cell with a one-hour doubling time will produce over 1 million offspring within twenty hours. If left unchecked, a single E. coli bacterium replicating once every twenty minutes could replicate to equal the mass of Earth in twenty-four hours. The enormous increase in cell numbers that accompanies this exponential growth provides these simple unicellular organisms with an incredible growth advantage over other unicellular or multicellular organisms. Luckily, there are always limits to bacterial growth.

The cytoplasm of a bacterial cell contains the deoxyribonucleic acid (DNA) molecules that make up the bacterial genome (or nucleoid), the transcriptional machinery that copies DNA into ribonucleic acid (RNA), and the ribosomes that translate the messenger RNA information into protein sequence. Since there is no nucleus, all of these processes occur simultaneously. The rapid growth rate of the bacterial cell requires constant DNA replication and ways to segregate the two new chromosomes into the two daughter cells without tangling them.

Structure and Diversity

Bacterial cells express a variety of shapes and sizes. The smallest bacteria are the Mycoplasmas, which range from about 0.1 to 0.25 micrometers in diameter, while the gigantic Epulopiscium fishelsoni is 250 micrometers long and visible to the naked eye. Some bacteria have a coccal (spherical) shape. Others are shaped as bacilli (rods), vibrio (curved rods), or spirochetes (spirals).

Bacterial cells are often classified by the structure of their cell envelope. All bacteria have a bilayer membrane that surrounds the cytoplasm. Integral membrane proteins within the cytoplasmic membrane are required to transport nutrients (sugars and amino acids) into the cell for growth. Most bacteria have a cell wall that is made up of peptidoglycan . This is a naturally occurring polymer , similar to chemicals that make up plastics and synthetic fabrics. Peptidoglycan is only found in bacterial cells.

Most bacteria are classified by how they react to a defined series of coloured dyes (the Gram stain). The Gram stain is the basis of one major classification scheme for bacteria. Gram-positive bacteria have a thick cell wall. The Gram-positive cell wall acts as a molecular barrier to prevent access to the cytoplasmic membrane and to keep large, harmful molecules from damaging the cell. In contrast, Gram-negative bacteria have a thin layer of peptidoglycan that makes up their cell wall that is surrounded by a second bilayer membrane called the outer membrane. The purple dye used in the Gram stain does not penetrate the outer membrane, and these cells do not stain purple. Gram-negative cells are instead identified by a pink color contributed by a different chemical stain during the Gram stain procedure. The Gram-negative outer membrane functions to protect the cytoplasmic membrane.

Most bacterial species express other molecules and structures outside of their cell envelope that are important for interactions with the environment. Polysaccharide capsules prevent desiccation of environmental microbes and allow pathogens to resist phagocytosys by mammalian white blood cells. Most bacterial species have flagella, which allow the bacteria cells to move around in aqueous environments. Most Gram-negative bacteria express hairlike appendages called pili or fimbriae that allow them to adhere to other bacteria, bacterial viruses, eukaryotic cells, or other physical surfaces. These exterior appendages help bacteria get to where they want to go, and then keep them there to facilitate growth.

Beneficial Bacteria

Most bacteria do not directly influence humans. However, a small number of bacterial species can cause human or animal diseases and are a major focus of scientific study. Other bacteria can be beneficial to humans by contributing to human nutrition and protecting the body from pathogens. The E. coli bacteria in our colons are an example. Bacterial cells such as E. coli are widely used in laboratories as factories to produce commercially or medically important proteins through the use of genetic engineering or recombinant DNA technologies. Other bacteria are important for agriculture since they take nitrogen from the air and replace it in the soil (nitrogen fixation). Bacteria are used to clean up oil spills and toxic chemicals in the environment. There are as many beneficial bacteria as there are destructive germs.

HANDS-ON PART OF THE LESSON (30 MINUTES)

Let's explore! (10 MINUTES)

Next, students explore models and images of different types of bacteria. As students explore, they are asked to consider the similarities and differences between them (writing and drawing what they see) (cocci_bacteria and bacilli_bacteria). A discussion in the group follows (What was the most obvious difference between the two types of bacteria? Why do you think they may have this difference?)

Let's learn! (20 MINUTES)

Cocci bacteria are sphere-shaped, whereas bacilli bacteria are rod-shaped. See these and other shapes in the provided images.

What are bacteria?

After discussion, students watch a video/PPT presentation to learn the key characteristics of bacteria.

https://www.youtube.com/watch?v=pcXdfofLoj0

https://edpuzzle.com/media/60603a3d381eb54275128f71 with activities

After the video, students participate in a few activities to check for understanding of the key ideas. (Explore a model/image of cyanobacteria. Write down how they can tell it is a bacterium. What questions do they still have about bacteria?)

EXERCISE PART (12 MINUTES)

Let's apply what we have learned!

The accompanying extension activity reinforces student knowledge of bacterial structure through constructing a model of a bacterium using an image of a bacterium.

In this activity groups of 4 – 5 students work together to construct a model of a bacterial cell.

Materials:

Modelling clay

String

Wooden or plastic beads

Cling wrap

Tooth picks – cut in tiny pieces

Instructions:

1. The modelling clay is going to represent your cell body – the cytoplasm. Place a glob of clay and make it the shape of your bacteria. You can make it any shape: coccus, bacillus, or spirillum. What is the shape you chose?

2. The string represents the DNA. Place it in the nucleoid region. What kind of DNA does a bacterial cell have?

3. The beads represent the ribosomes. Place them around your cell.

a. What is the purpose of ribosomes?

b. If bacterial cells have no membrane bound organelles then why do they have ribosomes?

4. The cling wrap is going to represent a cell wall.

a. What is a bacterial cell wall made from?

5. The tooth picks represent pili – poke them through the cling wrap and into the clay. What is the purpose of pili?

CONCLUSION (2 MINUTES)

Let's evaluate what we have learned!

“If you were looking at models of different types of cells, how could you tell which ones were bacteria? Use drawings to support your explanation.

What questions do you still have about the topic of today’s lesson?

SYNTHESIS/SUMMARY (8 MINUTES)

Students work in groups to make a diagram about the key elements in the lesson. They use the provided materials (bacteria notes). At the end of the lesson they stick/upload their diagrams to the board.

WORKSHEET

INCLUSIVENESS GUIDELINES

LITERATURE - BIBLIOGRAPHY (Optional)

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