tpo_38_passage_1

Before microscopes were first used in the seventeenth century, no one knew that living organisms were composed of cells. The first microscopes were light microscopes, which work by passing visible light through a specimen. Glass lenses in the microscope bend the light to magnify the image of the specimen and project the image into the viewer's eye or onto photographic film. Light microscopes can magnify objects up to 1,000 times without causing blurriness. Magnification, the increase in the apparent size of an object, is one important factor in microscopy. Also important is resolving power, a measure of the clarity of an image. Resolving power is the ability of an optical instrument to show two objects as separate. For example, what looks to the unaided eye like a single star in the sky may be resolved as two stars with the help of a telescope. Any optical device is limited by its resolving power. The light microscope cannot resolve detail finer than 0.2 micrometers, about the size of the smallest bacterium; consequently, no matter how many times its image of such a bacterium is magnified, the light microscope cannot show the details of the cell's internal structure. From the year 1665, when English microscopist Robert Hooke discovered cells, until the middle of the twentieth century, biologists had only light microscopes for viewing cells. But they discovered a great deal, including the cells composing animal and plant tissues, microscopic organisms, and some of the structures within cells. By the mid-1800s, these discoveries led to the cell theory, which states that all living things are composed of cells and that all cells come from other cells. Our knowledge of cell structure took a giant leap forward as biologists began using the electron microscope in the 1950s. Instead of light, the electron microscope uses a beam of electrons and has a much higher resolving power than the light microscope. In fact, the most powerful modern electron microscopes can distinguish objects as small as 0.2 nanometers, a thousandfold improvement over the light microscope. The period at the end of this sentence is about a million times bigger than an object 0.2 nanometers in diameter, which is the size of a large atom. Only under special conditions can electron microscopes detect individual atoms. However, cells, cellular organelles, and even molecules like DNA and protein are much larger than single atoms. Biologists use the scanning electron microscope to study the detailed architecture of cell surfaces. It uses an electron beam to scan the surface of a cell or group of cells that have been coated with metal. The metal stops the beam from going through the cells. When the metal is hit by the beam, it emits electrons. The electrons are focused to form an image of the outside of the cells. The scanning electron microscope produces images that look three-dimensional. The transmission electron microscope, on the other hand, is used to study the details of internal cell structure. Specimens are cut into extremely thin sections, and the transmission electron microscope aims an electron beam through a section, just as a light microscope aims a beam of light through a specimen. However, instead of lenses made of glass, the transmission electron microscope uses electromagnets as lenses, as do all electron microscopes. The electromagnets bend the electron beam to magnify and focus an image onto a viewing screen or photographic film. Electron microscopes have truly revolutionized the study of cells and cell organelles. Nonetheless, they have not replaced the light microscope. One problem with electron microscopes is that they cannot be used to study living specimens because the specimen must be held in a vacuum chamber; that is, all the air and liquid must be removed. For a biologist studying a living process, such as the whirling movement of a bacterium, a light microscope equipped with a video camera might be better than either a scanning electron microscope or a transmission electron microscope. Thus, the light microscope remains a useful tool, especially for studying living cells. The size of a cell often determines the type of microscope a biologist uses to study it.

question 1

According to paragraph 1, what happens to the light when a specimen is being viewed with a light microscope?

A The light continues unchanged directly into the viewer’ s eye or onto film.

B A glass lens bends the light to form a magnified image of the specimen.

C The light is projected onto photographic film to produce a blurred image.

D The intensity of the light increases a thousand times.

question 2

Why does the author mention "a telescope" as part of the discussion of microscopes?

A To show how microscopes and telescopes are different

B To emphasize the importance of magnification in all optical devices

C To explain how the development of the microscope depended on the invention of the telescope

D To illustrate the concept of resolving power

question 3

Which of the sentences below best expresses the essential information in the highlighted sentence in the passage? Incorrect choices change the meaning in important ways or leave out essential information.

A A light microscope has the power to greatly magnify a bacterium that is smaller than 0.2 micrometers.

B A light microscope can only resolve objects 0.2 micrometers or larger, so it cannot show the interior form of a cell.

C The smallest bacterium has a complex internal structure that can be seen with a light microscope.

D The greater the magnifying power of a light microscope, the greater its ability to resolve the internal structure of a cell.

question 4

What can be inferred from paragraph 3 about the scientific contribution of Robert Hooke?

A His discovery of cells resulted from the examination of animal tissue rather than plant tissue.

B He was the first person to develop and explain cell theory.

C He discovered cells using a light microscope.

D The full significance of his work was first understood in the mid-nineteenth century.

question 5

The word "giant" in the passage is closest in meaning to

A huge

B expected

C complex

D sudden

question 6

According to paragraph 4, which of the following is true of electron microscopes?

A They do not use light to magnify and resolve objects.

B They can magnify the internal structure of a single atom.

C Their earliest versions were not significantly more powerful than light microscopes.

D They had to be modified extensively for their use in biology research.

question 7

According to paragraph 5, what is the role of metal in the scanning electron microscope?

A It magnifies the light that passes through the cells.

B It coats the surface of cells with a protective cover.

C It enables the production of images showing the surface structure of cells.

D It reveals details hidden underneath the surfaces of cells.

question 8

According to paragraphs 5 and 6, the transmission electron microscope differs from the scanning electron microscope in all of the following ways EXCEPT:

A Specimens viewed by transmission electron microscopes are divided into cross sections.

B The transmission electron microscope uses electromagnets as lenses.

C The transmission electron microscope passes an electron beam through a specimen.

D The transmission electron microscope focuses on the inner structure of a cell.

question 9

Look at the four squares [ ] that indicate where the following sentence could be added to the passage.

Before microscopes were first used in the seventeenth century, no one knew that living organisms were composed of cells. The first microscopes were light microscopes, which work by passing visible light through a specimen. Glass lenses in the microscope bend the light to magnify the image of the specimen and project the image into the viewer's eye or onto photographic film. Light microscopes can magnify objects up to 1,000 times without causing blurriness. Magnification, the increase in the apparent size of an object, is one important factor in microscopy. Also important is resolving power, a measure of the clarity of an image. Resolving power is the ability of an optical instrument to show two objects as separate. For example, what looks to the unaided eye like a single star in the sky may be resolved as two stars with the help of a telescope. Any optical device is limited by its resolving power. The light microscope cannot resolve detail finer than 0.2 micrometers, about the size of the smallest bacterium; consequently, no matter how many times its image of such a bacterium is magnified, the light microscope cannot show the details of the cell's internal structure. From the year 1665, when English microscopist Robert Hooke discovered cells, until the middle of the twentieth century, biologists had only light microscopes for viewing cells. But they discovered a great deal, including the cells composing animal and plant tissues, microscopic organisms, and some of the structures within cells. By the mid-1800s, these discoveries led to the cell theory, which states that all living things are composed of cells and that all cells come from other cells. Our knowledge of cell structure took a giant leap forward as biologists began using the electron microscope in the 1950s. Instead of light, the electron microscope uses a beam of electrons and has a much higher resolving power than the light microscope. In fact, the most powerful modern electron microscopes can distinguish objects as small as 0.2 nanometers, a thousandfold improvement over the light microscope. The period at the end of this sentence is about a million times bigger than an object 0.2 nanometers in diameter, which is the size of a large atom. Only under special conditions can electron microscopes detect individual atoms. However, cells, cellular organelles, and even molecules like DNA and protein are much larger than single atoms. Biologists use the scanning electron microscope to study the detailed architecture of cell surfaces. It uses an electron beam to scan the surface of a cell or group of cells that have been coated with metal. The metal stops the beam from going through the cells. When the metal is hit by the beam, it emits electrons. The electrons are focused to form an image of the outside of the cells. The scanning electron microscope produces images that look three-dimensional. The transmission electron microscope, on the other hand, is used to study the details of internal cell structure. Specimens are cut into extremely thin sections, and the transmission electron microscope aims an electron beam through a section, just as a light microscope aims a beam of light through a specimen. However, instead of lenses made of glass, the transmission electron microscope uses electromagnets as lenses, as do all electron microscopes. The electromagnets bend the electron beam to magnify and focus an image onto a viewing screen or photographic film. Electron microscopes have truly revolutionized the study of cells and cell organelles. Nonetheless, they have not replaced the light microscope. [] One problem with electron microscopes is that they cannot be used to study living specimens because the specimen must be held in a vacuum chamber; that is, all the air and liquid must be removed. [] For a biologist studying a living process, such as the whirling movement of a bacterium, a light microscope equipped with a video camera might be better than either a scanning electron microscope or a transmission electron microscope. [] Thus, the light microscope remains a useful tool, especially for studying living cells. [] The size of a cell often determines the type of microscope a biologist uses to study it.

question 10

Directions: Select from the seven sentences below the three sentences that correctly characterize light microscopes and the two sentences that correctly characterize electron microscopes. Drag each sentence you select into the appropriate column of the table. Two of the sentences will NOT be used. This question is worth 3 points.

A. Their lenses are made of glass.

B. They use magnetism to bring images into focus.

C. They were invented in the mid-1800s.

D. They are used to study living pecimens.

E. They can produce images that appear three-dimensional.

F. They cannot resolve the internal structure of small cells.

G. They can usually resolve details smaller than the size of an atom.