

MICROBE MISSION

STATION 1

DICHOTOMOUS KEY TO SELECTED BACTERIA

1. (a) Cell shape is a bacillus go to 2
(b) Cell shape is not a bacillus. go to 4

2. (a) Cells form endospores ***Bacillus subtilis* (A)**
(b) Cells do not form endospores go to 3

3. (a) Cells arranged in a streptobacillus pattern ***Bacillus anthracis* (B)**
(b) Cells not arranged in a streptobacillus pattern. ***Pseudomonas aeruginosa* (C)**

4. (a) Bacteria are gram-positive go to 5
(b) Bacteria are gram-negative go to 8

5. (a) Cells occur singly ***Micrococcus luteus* (D)**
(b) Cells occur in pairs or clumps go to 6

6. (a) Cells form diplococci ***Enterococcus faecalis* (E)**
(b) Cells do not form diplococci go to 7

7. (a) Cells arranged in a streptococcus pattern ***Streptococcus pneumoniae* (AB)**
(b) Cells arranged in a staphylococcus pattern. ***Staphylococcus aureus* (AC)**

8. (a) Cell shape is coccus ***Neisseria gonorrhoeae* (AD)**
(b) Cell shape is not a coccus go to 9

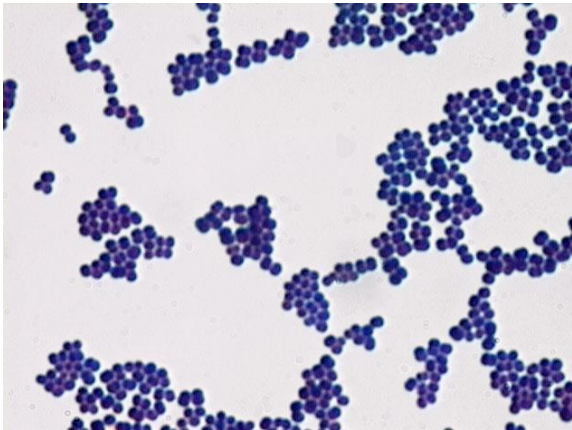
9. (a) Cell shape is a vibrio ***Vibrio cholera* (AE)**
(b) Cell shape is a spirillum ***Spirillum volutans* (BC)**

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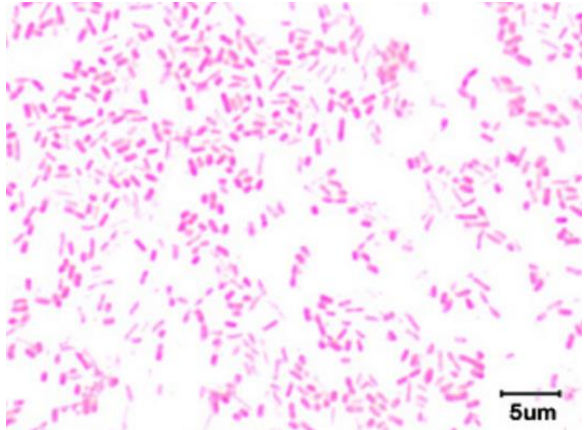
STATION 1

IMAGES OF BACTERIA

Specimen A:



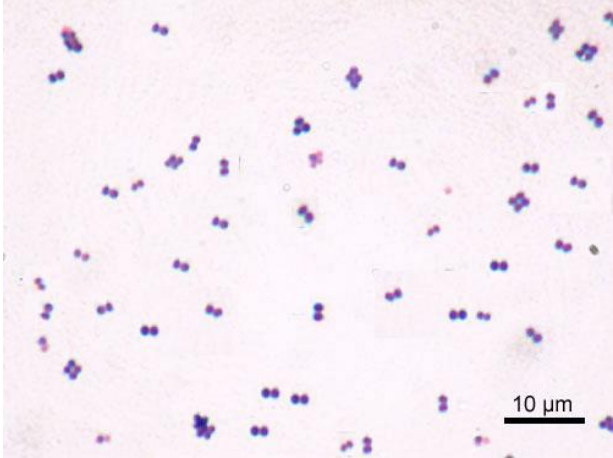
Specimen B:



Specimen C:



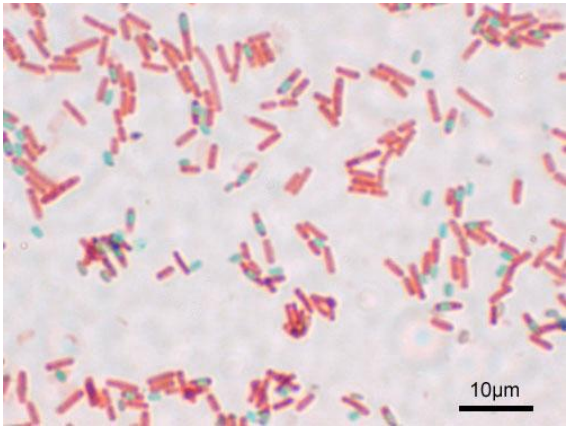
Specimen D:



Specimen E:



Specimen F:



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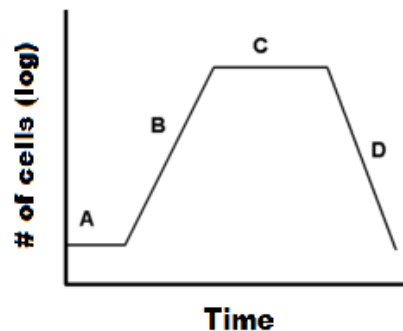
STATION 1 QUESTIONS

Using the dichotomous key provided at this station, identify each of the bacteria specimens pictured. Mark the letter(s) of your choice on the answer sheet provided.

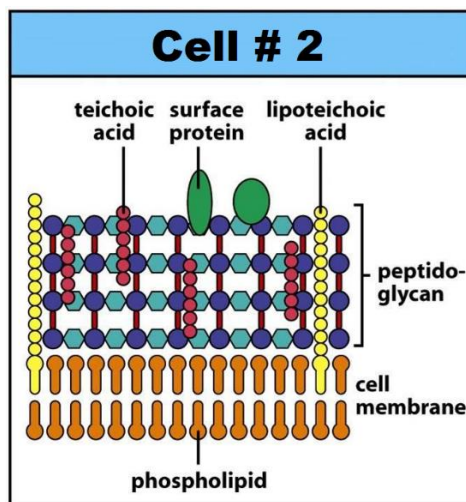
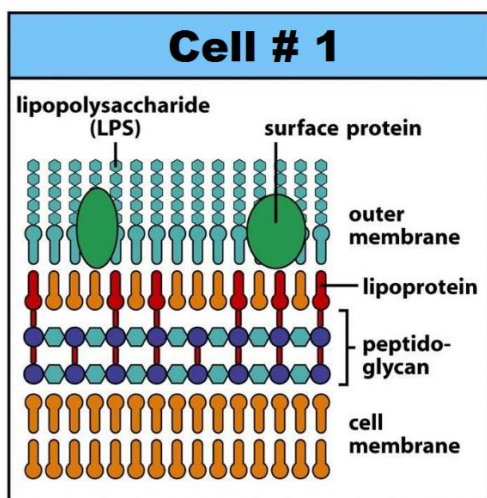
- | | | |
|---------------|---------------|---------------|
| 1) Specimen A | 3) Specimen C | 5) Specimen E |
| 2) Specimen B | 4) Specimen D | 6) Specimen F |

The graph below depicts the growth of bacterial cells in a liquid medium.

- 7) Which of these reasons **best** explains the shape of the growth curve during phase A?
- The growth of the bacteria during phase A is very slow because of a lack of resources.
 - Growth rate equals death rate for the bacteria in this phase due to competition between cells.
 - The individual bacterial cells take longer to divide during phase A than they do in later phases.
 - There are relatively few cells in the culture during phase A.



Examine the images below to answer questions #8 – 11.



- 8) If a gram stain procedure was performed on **Cell #1**, the cells would appear _____ and would be identified as gram-_____.
- purple; positive
 - purple; negative
 - pink; positive
 - pink; negative
- 9) After gram staining **Cell #1**, the name of the stain that is visible at the end is
- ethyl alcohol.
 - crystal violet.
 - safranin.
 - Gram's iodine.
- 10) If a gram stain procedure was performed on **Cell #2**, the cells would appear _____ and would be identified as gram-_____.
- purple; positive
 - purple; negative
 - pink; positive
 - pink; negative
- 11) After gram staining **Cell #2**, the name of the stain that is visible at the end is
- ethyl alcohol.
 - crystal violet.
 - safranin.
 - Gram's iodine.

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STATION 2 QUESTIONS

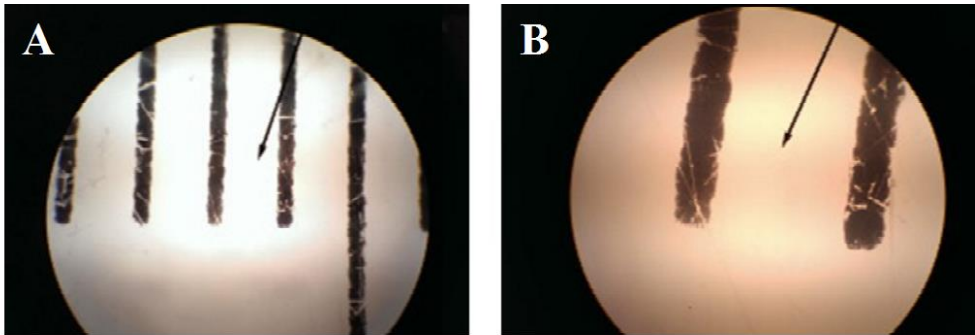


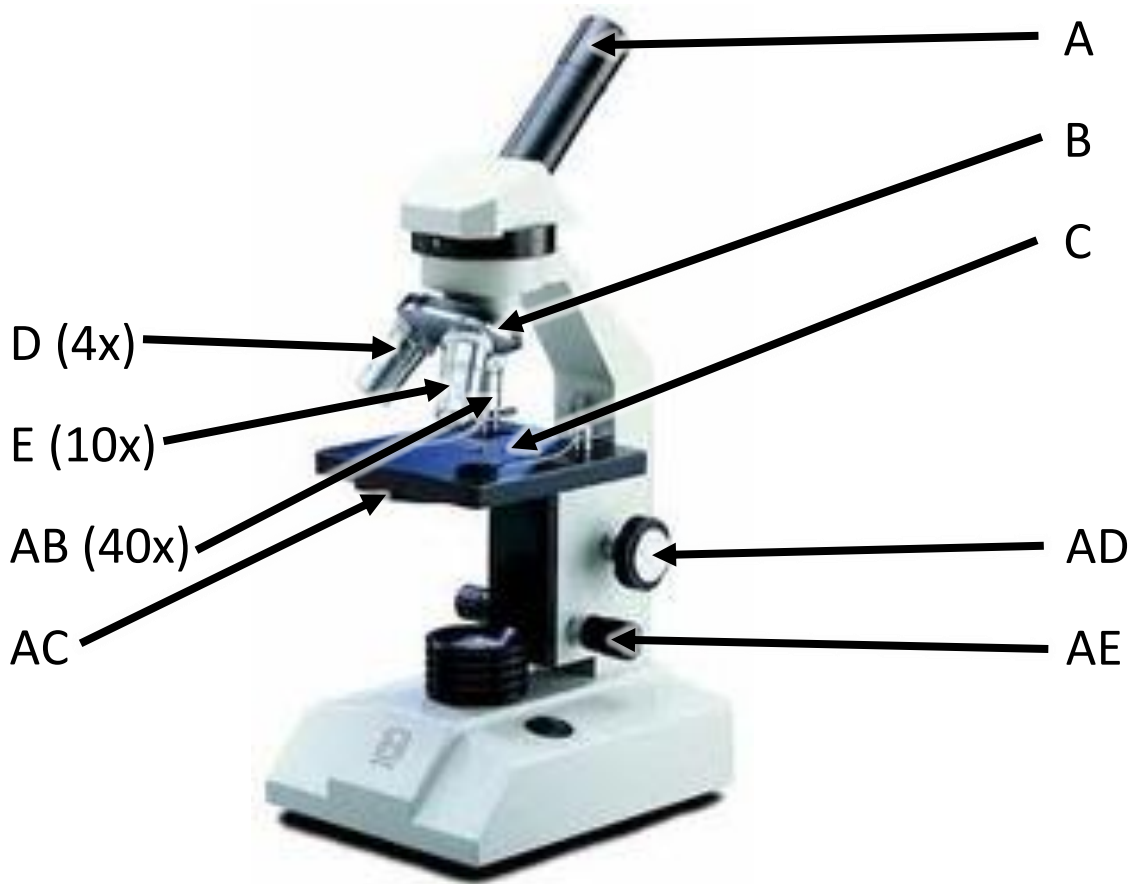
Figure 1. Millimeter ruler viewed under a compound light microscope at two different magnifications.

- 12) Refer to figure 1 above. Image A represents the field of view as seen under a 5x objective lens. Image B represents a higher magnification view of the ruler using the same microscope. The ocular lens of this microscope has a magnification of 10x. What is the **total magnification** of image B?
- A) 50x B) 100x C) 130x D) 150x
- 13) A newspaper ad for a local toy store indicates that a very inexpensive microscope available for a small child is able to magnify specimens nearly as much as the much more costly microscope available in a college lab. What is the primary reason for the price difference?
- A) The ad agency is misrepresenting the ability of the toy microscope to magnify.
B) The toy microscope does not have the same fine control for focus of the specimen.
C) The toy microscope magnifies a good deal, but has low resolution and therefore poor quality images.
D) The college microscope produces greater contrast in the specimens.
E) The toy microscope usually uses a different wavelength of light source.
- 14) The smallest cell structure that would most likely be visible with a standard (not super-resolution) research-grade light microscope is
- A) a mitochondrion. C) a ribosome.
B) a microtubule. D) a nuclear pore.

Refer to the labeled microscope at this station to match the microscope part with the correct name or description. **Some microscope parts may be used more than once.**

- 15) Adjusts the amount of light that passes through the specimen
16) Coarse adjustment knob
17) Scanning power objective
18) Raises/lowers the stage to bring an image into focus quickly when using a low power objective
19) Nosepiece
20) Fine adjustment knob
21) Ocular lens
22) Lens that would be used to view a specimen at 100x total magnification
23) Turning this part of the microscope allows the viewer to alter the total magnification

Parts of the microscope as labeled at this station:



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STATION 3 QUESTIONS

Use the set of cards located at this station to match each microbial disease with the correct description. After determining the correct matches, record the letter of the description that matches each disease on the corresponding number on your answer sheet.

- 24) Anthrax
- 25) Dutch Elm Disease
- 26) Ebola
- 27) Giardiasis
- 28) Kuru
- 29) Lyme Disease
- 30) Mononucleosis
- 31) Ringworm
- 32) Rocky Mountain Spotted Fever
- 33) Schistosomiasis
- 34) Strep Throat
- 35) Tapeworm

36) It is important to distinguish between Gram-positive and Gram-negative bacteria in diagnosing a bacterial infection because


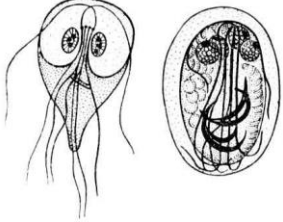

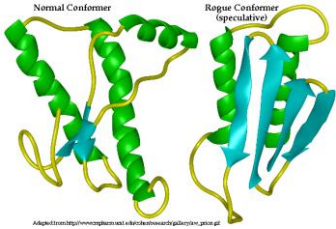
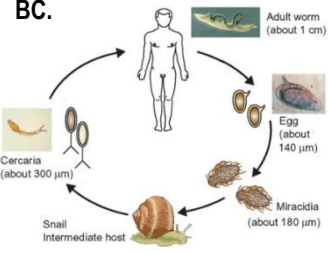
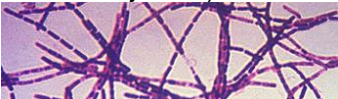
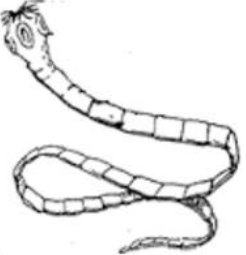
- A) Gram-negative and Gram-positive bacteria differ in their response to different antibiotics.
- B) Gram-positive bacteria never cause fatal diseases.
- C) Gram-positive bacteria destroy antibiotics, preventing them from working.
- D) Gram-positive bacteria do not respond to many antibiotics.

37) Bacteria that cause botulism may survive in canned food for a long time because

- A) the can was left open.
- B) some cans may contain viruses that protect the bacteria.
- C) the bacteria may form endospores.
- D) sterilized cans do not have enough oxygen to harm the bacteria.

38) Prions

- A) always have a capsid
- B) change the shape of normal proteins.
- C) cause abnormal growth in plants.
- D) are made of RNA.
- E) are made of DNA.

<p>26. Ebola</p>	<p>A. Spread through contact with bodily fluids, this viral disease is characterized by fever, fatigue, vomiting, and internal or external bleeding.</p>	<p>31. Ringworm</p>	<p>B. Fungal skin infection characterized by red, circular infected patches and is spread by contact with infected individuals, soil, and even pets.</p>
<p>30. Mononucleosis</p>	<p>C. This viral disease is characterized by sore throat, swollen lymph nodes, and fatigue that may persist for several weeks. Complications can be serious, and include spleen and liver issues.</p>	<p>25. Dutch Elm Disease</p>	<p>D. This disease is spread by contact with beetles that are contaminated with fungal spores and causes blockage within vascular tissue.</p>
<p>29. Lyme Disease</p>	<p>E. This tick-borne bacterial infection results in skin lesions such as these:</p> 	<p>27. Giardiasis</p>	<p>AB. Caused by this microbe:</p> 
<p>32. Rocky Mountain Spotted Fever</p>	<p>AC. This tick-borne bacterial infection results in skin lesions such as these:</p> 	<p>28. Kuru</p>	<p>AD. Caused by this microbe:</p> 
<p>34. Strep Throat</p>	<p>AE. This bacterial disease is characterized by sore throat, swollen lymph nodes, and fever of 101°F or more. Resulting complications may include a skin rash known as Scarlet Fever.</p>	<p>33. Schistosomiasis</p>	<p>BC.</p> 
<p>24. Anthrax</p>	<p>BD. Disease caused by the microbe below takes different forms, depending on exposure (cutaneous, inhalation, gastrointestinal, injection).</p> 	<p>35. Tapeworm</p>	<p>BE. Caused by this microbe:</p> 

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STATION 4

39) A slide of the letters F and R is placed on the stage of a microscope in the position shown in the diagram. How would the image of the letters appear when viewed under low power of a compound light microscope?

- A) **RF** B) **ƆƆ** C) **᠙᠙** D) **᠎᠎**



40) A microscope is supplied with 10x and 15x eyepieces, and with 10x and 44x objectives. What is the maximum magnification that can be obtained from this microscope?

- A) 59x B) 150x C) 440x D) 660x E) 4000x

41) A student prepares a wet mount of an amoeba and observes it under three powers of magnification of a compound light microscope (10x, 100x, 400x). An adjustment should be made to allow more light to pass through the specimen when the student changes magnification from

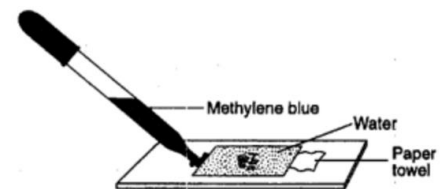
- A) 100x to 400x B) 400x to 100x C) 400x to 40x D) 110x to 40x

42) When focusing a microscope on high power, a student crushed the cover slip. The student probably

- A) closed the diaphragm C) forgot to use immersion oil
B) rotated the eyepiece D) used the coarse adjustment

43) The diagram shown represents a technique used in the preparation of a specimen for observation with a compound light microscope. Which technique is illustrated in the diagram?

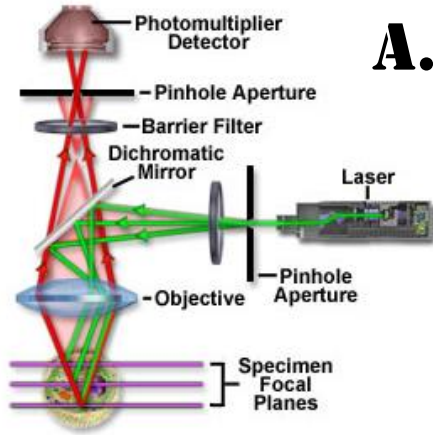
- A) preparing the slide for viewing under oil immersion
B) placing the specimen under the coverslip
C) sterilizing the specimen
D) staining the specimen



At this station you will find cards depicting the name of a type of microscope and an image of a specimen viewed through that microscope, a diagram of the principle behind the type of microscope, or a picture of the microscope itself. Match each microscope name with the corresponding image, then mark the letter of the image on the corresponding number of your answer sheet.

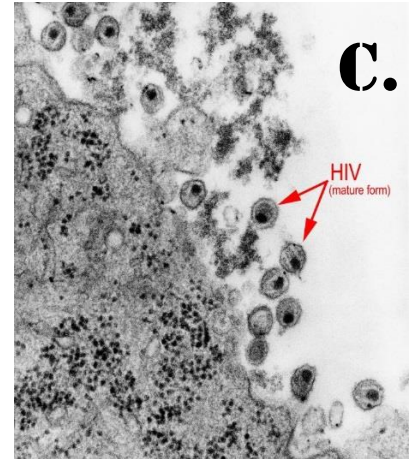
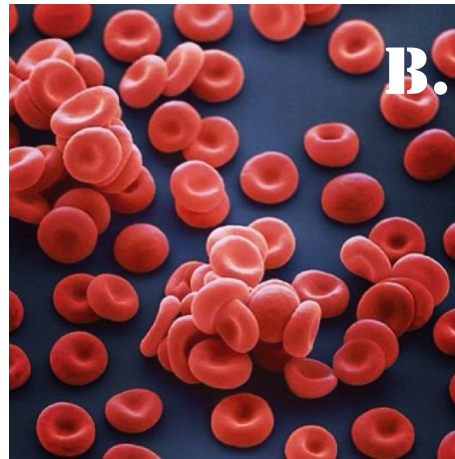
- 44) Compound Light Microscope
45) Confocal Microscope
46) Fluorescence Microscope
47) Scanning Electron Microscope
48) Stereo Microscope
49) Transmission Electron Microscope

**45.
CONFOCAL
MICROSCOPE**

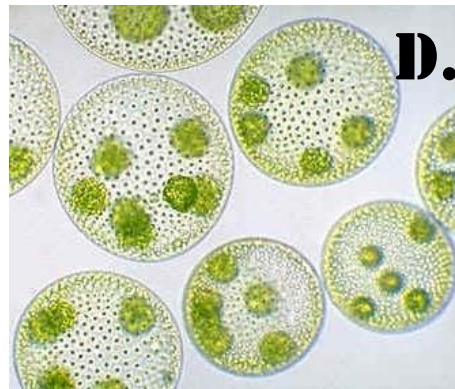


**49.
TRANSMISSION
ELECTRON
MICROSCOPE
(TEM)**

**47.
SCANNING
ELECTRON
MICROSCOPE
(SEM)**

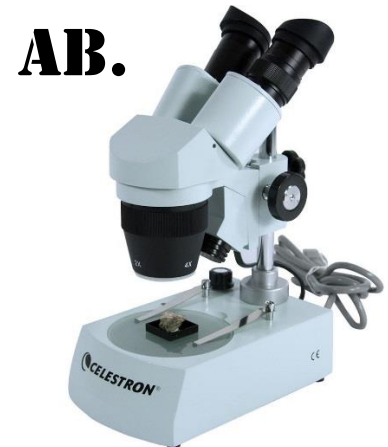
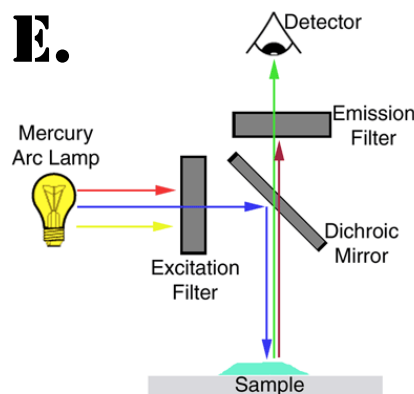


**44.
COMPOUND
LIGHT
MICROSCOPE**



**48.
STEREO
MICROSCOPE**

**46.
FLUORESCENCE
MICROSCOPE**



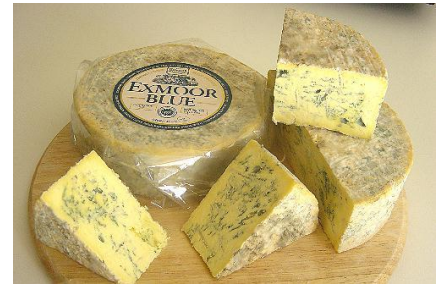
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STATION 5 QUESTIONS

Answer these questions about microbes and food:

50) Blue cheese, such as the brand pictured to the right, gets its distinctive flavor and marbling from what type of microbe?

- A) algae
- B) yeast
- C) fungus
- D) bacteria
- E) archaea



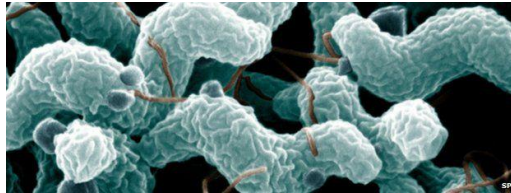
51) Which process is used to sterilize some foods, such as fruit juices, so that they are safe for human consumption?

- A) pasteurization
- B) homogenization
- C) high speed centrifugation
- D) ultra-fractionation

52) In order to prevent the spoilage of food by different microbes, it is important to **avoid** keeping food within the so-called “danger zone” temperature range of

- A) 50°F to 100°F
- B) 40°F to 140°F
- C) 98°F to 120°F
- D) 32°F to 212°F

53) The image below shows *Campylobacter*. How does this organism relate to the preparation of food?



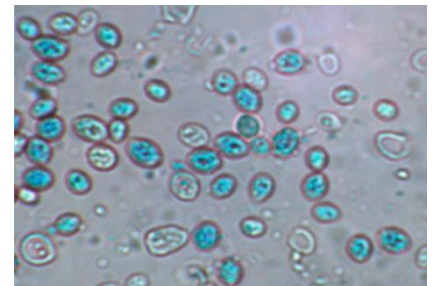
- A) It is used in the fermentation of barley to produce beer.
- B) It digests complex carbohydrates in bread dough, reducing them to simple sugars and resulting in a sweet taste.
- C) It grows on food left at room temperature, giving the food a fuzzy appearance and unappealing taste.
- D) It is commonly found in and on raw chicken and is a significant source of food poisoning.

54) What microbe is shown in the image to the right?

- A) yeast
- B) invertebrate animal
- C) protozoan
- D) bacteria

55) What type of food is made with this organism?

- A) yogurt
- B) cheese
- C) pickles
- D) bread



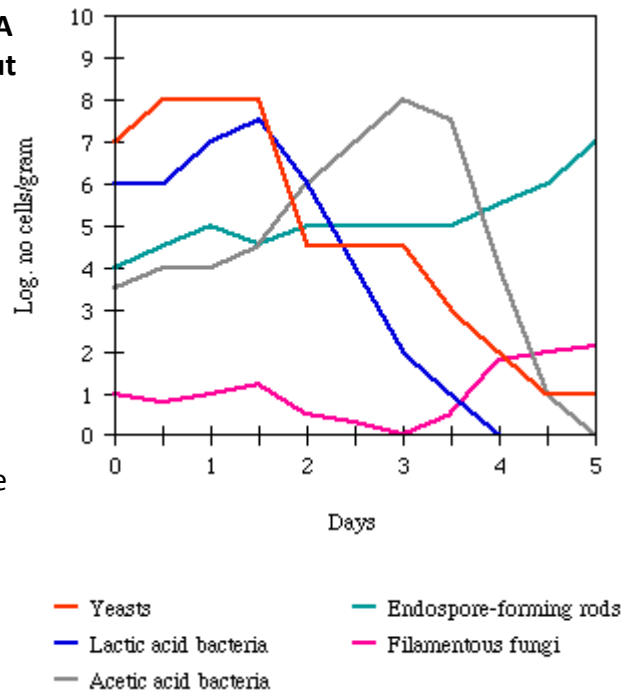
56) During the preparation of food, _____ is the movement of harmful microorganisms from one surface to another.

- A) contamination
- B) sanitation
- C) cross-contamination
- D) homogenization

57) What is the ideal temperature range for yeast fermentation?

- A) 78 – 82 °F
- B) 80 – 90 °F
- C) 85 – 95 °F
- D) 176 – 220 °F

Chocolate acquires its color and flavor during fermentation. A variety of microorganisms grow in the fermentation heap, but they do not all grow at the same time (see graph). Answer the remaining three questions using the information in the graph.



58) What conclusion can be drawn from the data shown in the graph to the right?

- A) Yeasts and lactic acid bacteria are not important in the fermentation of chocolate because they die out within five days.
- B) Endospore-forming rods are likely responsible for the formation of lactic acid beginning on the first day of fermentation.
- C) Filamentous fungi are important to the development of complex flavor in the fermenting chocolate because they are present in low concentration throughout the fermentation process.
- D) As various microbes grow in the fermenting chocolate, they alter the physical environment and allow new groups of microbes to become more common.

59) On which day would there likely be the highest concentration of sucrose (sugar)?

- A) 0
- B) 2
- C) 4
- D) 5

60) Calculate the growth rate of acetic acid bacteria from days 2-3.

- A) 0 log no cells/gram·day
- B) 2 log no cells/gram·day
- C) 6 log no cells/gram·day
- D) 8 log no cells/gram·day

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STATION 6 QUESTIONS

It has been well documented that populations of protozoans increase when water is polluted. The presence of protozoans may simply indicate that these organisms feed on the bacteria, the active decomposers of organic matter in the water system. Imagine that you are working with a team of scientists to determine whether protozoans, like bacteria, have any beneficial effects on a water-purification system. The line at the top of the grid in Figure 19-3 shows the rate of decomposition of hay in water when bacteria are acting alone. The lower line shows the rate of decomposition when bacteria and mixed protozoans are present.

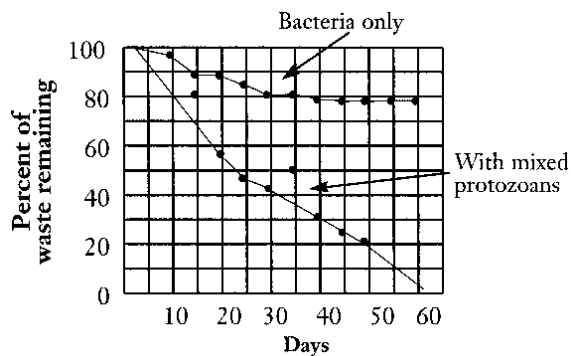


Figure 19-3

- 61) Suppose that very little of the waste matter disappeared in 50 days when protozoans were acting alone. Using Figure 19-3, what might you hypothesize then about the relationship between protozoans and bacteria?
- A) The bacteria and protozoans have some type of mutual feeding relationship; the bacteria may be able to perform biochemical pathways not present in the protozoans.
 - B) The bacteria and the protozoans compete for the available nutrients, causing a decline in both populations and overall underutilization of resources.
 - C) The protozoans are obligate endosymbionts of the bacteria and cannot survive without the presence of the host cells.
 - D) The bacteria are pathogens of the protozoans.
- 62) Which statement is a correct interpretation of Figure 19-3?
- A) Waste is decomposed at twice the rate when protozoans are present than when bacteria alone are present.
 - B) When mixed protozoans are present with the bacteria, 80 percent of the waste matter has been decomposed after 50 days.
 - C) Between days 40 and 60, bacteria alone are decomposing waste at a rate of 20% per day.
 - D) Initially, the bacteria alone decompose waste at a much faster rate than the bacteria population with mixed protozoans.
 - E) On day 10, most of the waste decomposition is accomplished by the bacteria, not the protozoans.

- 63) What are two of the most important eukaryotic features that evolved in protists?
- A) pseudopodia and cilia
 - B) photosynthesis and silica shells
 - C) multicellularity and sexual reproduction
 - D) spores and microtubules
- 64) The kingdom Protista does **not** include
- A) multicellular seaweed.
 - B) slime and water molds.
 - C) most of the single-celled eukaryotes.
 - D) prokaryotes.
- 65) Algae are
- A) usually heterotrophic.
 - B) always microscopic in size.
 - C) found in fresh water, salt water, and damp soil.
 - D) found only in fresh water.
- 66) Which of the following is **not** a human disease caused by a protist?
- A) Giardiasis
 - B) Paralytic Shellfish Poisoning
 - C) Cryptosporidiosis
 - D) Dengue fever
- 67) What factor makes the tropics a favorable environment for the spread of malaria?
- A) high rainfall
 - B) common salt water
 - C) large desert areas
 - D) long days
- 68) The protist that causes malaria reproduces in the
- A) intestine of a human.
 - B) red blood cells of a human.
 - C) red blood cells of a mosquito.
 - D) saliva of a mosquito.
- 69) Malaria is caused by several species of
- A) *Toxoplasma*.
 - B) *Giardia*.
 - C) *Phytophthora*.
 - D) *Plasmodium*.
- 70) Which of the following are actual mutualistic partnerships that involve a protist and a host organism?
- A) cellulose-digesting gut protists—wood-eating termites
 - B) dinoflagellates—reef-building coral animals
 - C) *Pfiesteria*—humans
 - D) algae—certain foraminiferans
 - E) all except that involving humans

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STATION 7

TIEBREAKER

★The question at this station will only be graded in the event of a tie between two or more teams.★

Write your answer to this question on the lined paper provided at this station; be sure to write your **TEAM NAME** on the answer sheet, or you will not receive credit.

Answers do not need to be written in complete sentences, but must be legible in order to earn points. When writing your answer, clearly mark which part of the question (a, b, c) you are answering.

During an investigation of a freshwater lake, a biology student discovers a previously unknown microbe. Further study shows that the microbe is eukaryotic.

- (a) **Identify** THREE organelles that should be present in the eukaryotic organism and **describe** the function of each organelle.
- (b) Prokaryotic cells lack membrane-bound organelles found in eukaryotes. However, prokaryotes must perform many of the same functions as eukaryotes. For TWO of the organelles identified in part (a), **explain** how prokaryotic cells carry out the associated functions.
- (c) According to the endosymbiotic theory, some organelles are believed to have evolved through a symbiotic relationship between eukaryotic and prokaryotic cells. **Describe** ONE observation that supports the endosymbiotic theory.

