

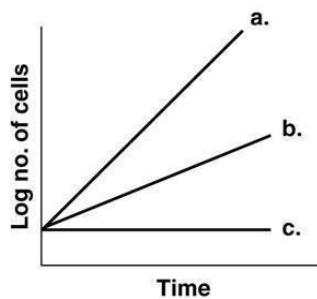
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Chapter 6 Microbial Growth

6.1 Multiple-Choice Questions

Figure 6.1



1) Figure 6.1, which line best depicts a facultative anaerobe in the absence of O₂?

- A) a
- B) b
- C) c

Answer: B

Section: 6.1

Bloom's Taxonomy: Analysis

ASMcue Outcome: 3.3

Learning Outcome: 6.5

Global Outcome: 3

2) In Figure 6.1, which line best depicts an obligate anaerobe in the presence of O₂?

- A) a
- B) b
- C) c

Answer: C

Section: 61

Bloom's Taxonomy: Analysis ASMcue Outcome: 3.....1

Learning Outcome: 6.....1

Global Outcome: 3

3) In Figure 6.1, which line shows the growth of an obligate aerobe incubated anaerobically?

- A) a
- B) b
- C) c

Answer: C

Section: 6.1

Bloom's Taxonomy: Analysis

ASMcue Outcome: 3.3

Learning Outcome: 6.5

Global Outcome: 3

4) In Figure 6.1, which line best illustrates the growth of a facultative anaerobe incubated aerobically?

- A) a
- B) b
- C) c

Answer: A

Section: 6.1

Bloom's Taxonomy: Analysis

ASMcue Outcome: 3.3

Learning Outcome: 6.5

Global Outcome: 3

5) In Figure 6.1, which line best depicts a psychrotroph incubated at 0°C?

- A) a
- B) b
- C) c

Answer: B

Section: 6.1

Bloom's Taxonomy: Comprehension

ASMcue Outcome: 3.3

Learning Outcome: 6.5

Global Outcome: 3

6) If cells are grown in media containing amino acids labeled with radioactive nitrogen (^{15}N), most of the radioactivity will be found in the cells'

- A) DNA.
- B) proteins.
- C) phospholipids.
- D) DNA and proteins.
- E) DNA and phospholipids.

Answer: D

Section: 6.1

Bloom's Taxonomy: Analysis

Learning Outcome: 6.4

Global Outcome: 2

7) Which of the following elements is NOT correctly matched with its cellular function?

- A) nitrogen — needed for amino acid synthesis
- B) phosphorus — incorporated into nucleic acids
- C) sulfur — used for synthesis of thiamin and biotin
- D) magnesium and potassium — required as cofactors for enzymes
- E) phosphorus — used for production of carbohydrates.

Answer: E

Section: 6.1

Bloom's Taxonomy: Knowledge

Learning Outcome: 6.4

8) Pathogenic bacteria isolated from the respiratory or intestinal tracts of humans are

- A) strict aerobes that grow best in candle jars.
- B) capnophiles that grow best in carbon dioxide incubators.
- C) facultative anaerobes that require reducing media for growth.
- D) strict aerobes that grow best in reducing media.
- E) capnophiles that prefer highly oxygenated growth conditions.

Answer: B

Section: 6.3

Bloom's Taxonomy: Analysis

ASMcue Outcome: 3.3

Learning Outcome: 6.9

Global Outcome: 2

9) The biosafety level (BSL) for most introductory microbiology laboratories is

- A) BSL-1.
- B) BSL-2.
- C) BSL-3.
- D) BSL-4.

Answer: A

Section: 6.3

Bloom's Taxonomy: Knowledge

ASMcue Outcome: 8.6

Learning Outcome: 6.10

10) The biosafety level (BSL) for a clinical microbiology laboratory working with potentially airborne pathogens, such as tuberculosis bacteria, is

- A) BSL-1.

- B) BSL-2.
- C) BSL-3.
- D) BSL-4.

Answer: C

Section: 6.3

Bloom's Taxonomy: Comprehension

ASMcue Outcome: 8.6

Learning Outcome: 6.10

Global Outcome: 2

11) A sample of milk is tested for its bacterial content in a plate count assay. A one-milliliter sample of the milk is diluted in a 1:10 dilution series. One milliliter of the third dilution tube is plated in a pour plate. After incubation, the plate has 54 colonies, indicating that the original milk sample contained

- A) 54 cells per milliliter. B)
- 540 cells per milliliter. C)
- 5,400 cells per milliliter. D)
- 54,000 cells per milliliter. E)
- 540,000 cells per milliliter.

Answer: D

Section: 6.6

Bloom's Taxonomy: Analysis

ASMcue Outcome: 8.4

Learning Outcome: 6.16

Global Outcome: 4

12) The addition of which of the following to a culture medium will neutralize acids?

- A) buffers
- B) sugars
- C) pH D)
- heat E)
- carbon

Answer: A

Section: 6.1

Bloom's Taxonomy: Knowledge

ASMcue Outcome: 8.5

Learning Outcome: 6.2

13) Salts and sugars work to preserve foods by creating a

- A) depletion of nutrients.
- B) hypotonic environment.
- C) lower osmotic pressure.

D) hypertonic environment.

E) lower pH.

Answer: D

Section: 6.1

Bloom's Taxonomy: Comprehension

Learning Outcome: 6.3

14) The term aerotolerant anaerobe refers to an organism that A) does not use oxygen but tolerates it.

B) is killed by oxygen.

C) tolerates normal atmospheric nitrogen gas levels.

D) requires less oxygen than is present in air.

E) requires more oxygen than is present in air.

Answer: A

Section: 6.1

Bloom's Taxonomy: Comprehension

ASMcue Outcome: 3.3

Learning Outcome: 6.5

15) Which of the following is an advantage of the standard plate count?

A) can readily count cells that form aggregates

B) determines the number of viable cells

C) can be performed on very dilute samples, such as lake water

D) provides immediate results

E) can be used to count heat-sensitive bacteria

Answer: B

Section: 6.6

Bloom's Taxonomy: Knowledge

ASMcue Outcome: 8.4

Learning Outcome: 6.16

16) Which of the following is an advantage of the direct microscopic count?

A) can readily count organisms that are motile

B) can easily distinguish live from dead cells

C) requires no incubation time

D) sample volume is unknown

E) requires a large number of cells

Answer: C

Section: 6.6

Bloom's Taxonomy: Comprehension

ASMcue Outcome: 8.4

Learning Outcome: 6.16

Global Outcome: 2

17) Most bacteria reproduce by

- A) aerial hyphae.
- B) fragmentation.
- C) mitosis.
- D) binary fission.
- E) budding.

Answer: D

Section: 6.6

Bloom's Taxonomy: Knowledge

Learning Outcome: 6.14

18) Thirty-six colonies grew in nutrient agar from 1.0 ml of undiluted sample in a standard plate count. How many cells were in the original sample?

- A) 4 per milliliter
- B) 9 per milliliter
- C) 18 per milliliter
- D) 36 per milliliter
- E) 72 per milliliter

Answer: D

Section: 6.6

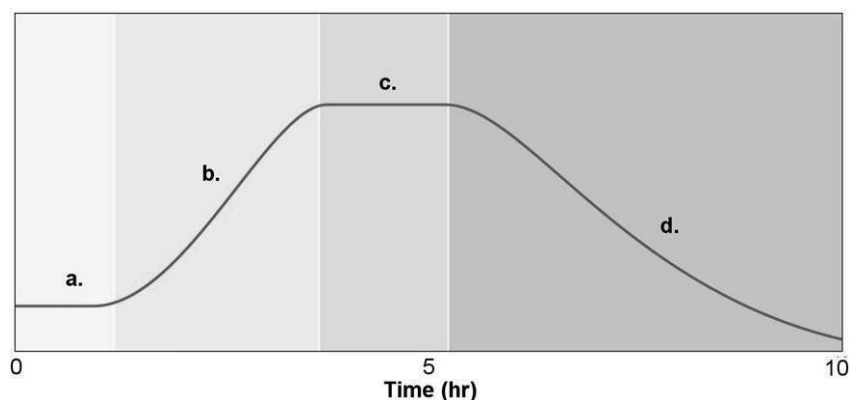
Bloom's Taxonomy: Comprehension

ASMcue Outcome: 8.4

Learning Outcome: 6.16

Global Outcome: 4

Figure 6.2



19) Figure 6.2 shows a typical bacterial growth curve with the y-axis indicating the log of the number of bacteria and the x-axis indicating time in culture. In the figure, which section (or sections) shows a growth phase where the number of cells dying equals the number of cells dividing?

- A) a

- B) b
- C) c
- D) d
- E) a and c

Answer: C

Section: 6.6

Bloom's Taxonomy: Comprehension

ASMcue Outcome: 7.2a

Learning Outcome: 6.15

Global Outcome: 3

20) Figure 6.2 shows a typical bacterial growth curve with the y-axis indicating the log of the number of bacteria and the x-axis indicating time in culture. In the figure, which sections of the graph illustrate a logarithmic change in cell numbers?

- A) a and c
- B) b and d
- C) a and b
- D) c and d
- E) a and d

Answer: B

Section: 6.6

Bloom's Taxonomy: Analysis

ASMcue Outcome: 7.2a

Learning Outcome: 6.15

Global Outcome: 3

21) Most bacteria grow best at pH

- A) 1.
- B) 5.
- C) 7.
- D) 9.
- E) 14.

Answer: C

Section: 6.1

Bloom's Taxonomy: Knowledge

ASMcue Outcome: 3.3

Learning Outcome: 6.2

22) Most fungi grow best at

pH A) 1.

- B) 5.
- C) 7.
- D) 9.

E) 14.

Answer: B

Section: 6.1

Bloom's Taxonomy: Knowledge

ASMcue Outcome: 3.3

Learning Outcome: 6.2

23) Consider a culture medium on which only gram-positive organisms such as *Staphylococcus aureus* colonies can grow due to an elevated NaCl level. A yellow halo surrounds the growth, indicating the bacterium fermented a sugar in the medium, decreasing the pH as a result and changing the color of a pH indicator chemical. This type of medium would be referred to as a(n)

A) selective medium.

B) differential medium.

C) enrichment culture.

D) selective and differential medium.

E) differential and enrichment culture.

Answer: D

Section: 6.3

Bloom's Taxonomy: Comprehension

ASMcue Outcome: 8.3

Learning Outcome: 6.9

24) A culture medium consisting of agar, peptone, and beef heart is a

A) chemically defined medium.

B) complex medium.

C) selective medium.

D) differential medium.

E) reducing medium.

Answer: B

Section: 6.3

Bloom's Taxonomy: Comprehension

ASMcue Outcome: 8.2

Learning Outcome: 6.8

25) Which of the following pairs of microbe classification terms and optimal growth temperatures is mismatched?

A) psychrotroph — growth at 0°C

B) thermophile — growth at 37°C

C) mesophile — growth at 25°C D)

psychrophile — growth at 15°C

E) hyperthermophiles — growth at 85°C

Answer: B

Section: 6.1

Bloom's Taxonomy: Knowledge

ASMcue Outcome: 3.3

Learning Outcome: 6.1

26) During which growth phase will gram-positive bacteria be most susceptible to penicillin?

- A) lag phase
- B) log phase
- C) death phase
- D) stationary phase
- E) The culture is equally susceptible during all phases.

Answer: B

Section: 6.6

Bloom's Taxonomy: Analysis

ASMcue Outcome: 3.4

Learning Outcome: 6.15

Global Outcome: 2

27) Which of the following is the best definition of generation time?

- A) the length of time needed for lag phase
- B) the length of time needed for a cell to divide
- C) the minimum rate of doubling
- D) the duration of log phase
- E) the time needed for nuclear division

Answer: B

Section: 6.6

Bloom's Taxonomy: Knowledge

Learning Outcome: 6.14

28) Which of the following is NOT a direct method to measure microbial growth? A) direct microscopic count

- B) standard plate count
- C) filtration on a support membrane followed by incubation on medium
- D) metabolic activity
- E) most probable number (MPN)

Answer: D

Section: 6.6

Bloom's Taxonomy: Comprehension

ASMcue Outcome: 8.4

Learning Outcome: 6.17

Global Outcome: 2

29) Which group of microorganisms is most likely to spoil a freshwater trout preserved with salt?

- A) psychrophiles
- B) facultative halophiles
- C) anaerobes
- D) thermophiles
- E) hyperthermophiles

Answer: B Section:

6.1

Bloom's Taxonomy: Analysis

ASMcue Outcome: 3.3

Learning Outcome: 6.3

Global Outcome: 2

30) Which of the following is an organic growth factor?

- A) glucose
- B) vitamin B1
- C) peptone D)
- Mg⁺²

E) H₂O

Answer: B

Section: 6.1

Bloom's Taxonomy: Comprehension

Learning Outcome: 6.4

Global Outcome: 2

31) Which of the following is an example of a metabolic activity that could be used to measure microbial growth?

- A) standard plate count B)
- glucose consumption C)
- direct microscopic count
- D) turbidity
- E) most probable number (MPN)

Answer: B

Section: 6.1

Bloom's Taxonomy: Comprehension

ASMcue Outcome: 8.4

Learning Outcome: 6.4

Global Outcome: 2

32) An experiment began with 4 cells and ended with 128 cells. How many generations did the cells go through?

- A) 64
- B) 32

C) 6

D) 5

E) 4

Answer: D

Section: 6.6

Bloom's Taxonomy: Analysis

ASMcue Outcome: 7.2

Learning Outcome: 6.15

Global Outcome: 4

33) Three cells with generation times of 60 minutes are inoculated into a culture medium. How many cells are there after 5 hours?

A) 900

B) 180

C) 96

D) 32

E) 15

Answer: C

Section: 6.6

Bloom's Taxonomy: Analysis

ASMcue Outcome: 7.2

Learning Outcome: 6.15

Global Outcome: 4

Figure 6.3



34) In Figure 6.3, which tube shows the expected growth pattern for a microaerophile? A) a

B) b C) c D)

d E) e

Answer: E

Section: 6.1

Bloom's Taxonomy: Analysis

ASMcue Outcome: 3.3

Learning Outcome: 6.5
Global Outcome: 3

- 35) In Figure 6.3, which tube shows the expected growth pattern for a facultative anaerobe?
A) a
B) b C) c D)
d E) e

Answer: B
Section: 6.1

Bloom's Taxonomy: Comprehension

ASMcue Outcome: 3.3

Learning Outcome: 6.5

Global Outcome: 3

36) In one hospital, *Pseudomonas aeruginosa* serotype 10 infected the biliary tract of 10 percent of 1300 patients who underwent gastrointestinal endoscopic procedures. After each use, endoscopes were washed with an automatic reprocessor that flushed detergent and glutaraldehyde through the endoscopes, followed by a tap water rinse. *P. aeruginosa* serotype 10 was not isolated from the detergent, glutaraldehyde, or tap water. What was the source of the infections?

- A) bacterial cell walls in the water
B) a biofilm in the reprocessor C)
contaminated disinfectant
D) fecal contamination of the bile ducts
E) None of the answers is correct.

Answer: B
Section: 6.2

Bloom's Taxonomy: Analysis

Learning Outcome: 6.7

Global Outcome: 2

Table 6.1

Three different culture media are shown below.

Medium A	Medium B	Medium C
Na ₂ HPO ₄	Tide detergent	Glucose
KH ₂ PO ₄	Na ₂ HPO ₄	Peptone
MgSO ₄	KH ₂ PO ₄	(NH ₄) ₂ SO ₄
CaCl ₂	MgSO ₄	KH ₂ PO ₂
NaHCO ₃	(NH ₄) ₂ SO ₄	Na ₂ HPO ₄

37) For the three types of media in Table 6.1, which medium (or media) is/are chemically defined?

- A) A
- B) B
- C) C
- D) A and B
- E) A and C

Answer: A

Section: 6.3

Bloom's Taxonomy: Analysis

Learning Outcome: 6.8

Global Outcome: 3

38) In Table, 6.1, in which medium (or media) would an autotroph grow?

- A) A
- B) B
- C) C
- D) A and B
- E) A and C

Answer: A

Section: 6.3

Bloom's Taxonomy: Analysis

ASMcue Outcome: 3.3

Learning Outcome: 6.8

Global Outcome: 3

39) Assume you inoculated 100 cells, with a generation time of 20 minutes, into 100 ml of nutrient broth. You then inoculated 100 cells of the same species into 200 ml of nutrient broth. After incubation for 4 hours, you can reasonably expect to have

- A) more cells in the 100 ml.
- B) more cells in the 200 ml.
- C) the same number of cells in both.
- D) The answer cannot be determined based on the information provided.

Answer: C

Section: 6.3

Bloom's Taxonomy: Analysis

Learning Outcome: 6.8

Global Outcome: 2

40) The source of nutrients in nutrient agar is

- A) agar.

- B) gelatin.
- C) peptone and beef extract.
- D) peptone and NaCl.
- E) agar and NaCl.

Answer: C

Section: 6.3

Bloom's Taxonomy: Comprehension

Learning Outcome: 6.8

Global Outcome: 2

41) Which enzyme catalyzes the reaction: $O_2^- + O_2^- + 2H^+ \rightarrow H_2O_2 + O_2$?

- A) catalase
- B) oxidase
- C) peroxidase
- D) superoxide dismutase

Answer: D

Section: 6.1

Bloom's Taxonomy: Knowledge

Learning Outcome: 6.6

42) Which enzyme catalyzes the reaction: $2H_2O_2 \rightarrow 2H_2O + O_2$?

- A) catalase
- B) oxidase
- C) peroxidase
- D) superoxide dismutase

Answer: A

Section: 6.1

Bloom's Taxonomy: Knowledge

Learning Outcome: 6.6

43) Which enzyme catalyzes the reaction: $H_2O_2 + 2H^+ \rightarrow 2H_2O$?

- A) catalase
- B) oxidase
- C) peroxidase
- D) superoxide dismutase

Answer: C

Section: 6.1

Bloom's Taxonomy: Knowledge

Learning Outcome: 6.6

44) Table 6.2

The following data show growth of two bacteria on different media.

	Amount of Growth	
	<i>Staphylococcus aureus</i>	<i>Streptococcus pyogenes</i>
Nutrient agar	++	++
Nutrient agar + 7.5% NaCl	+	-

The data in Table 6.2 indicate that *S. aureus* is a(n)

- A) mesophile.
- B) facultative anaerobe.
- C) facultative halophile.
- D) aerobe.
- E) halophile. Answer: C

Section: 6..... 1
 Bloom's Taxonomy: Analysis ASMcue Outcome: 3..... 1
 Learning Outcome: 6..... 1
 Global Outcome: 1

45) Patients with indwelling catheters (long-term tubes inserted into body orifices for drainage, such as through the urethra and into the urinary bladder) are susceptible to infections because

- A) injected solutions are contaminated.
- B) their immune systems are weakened.
- C) infections can be transmitted from other people.
- D) biofilms develop on catheters.
- E) bacteria cause infections.

Answer: D
 Section: 6.2
 Bloom's Taxonomy: Comprehension
 ASMcue Outcome: 5.2
 Learning Outcome: 6.7

Global Outcome: 2

6.2 True/False Questions

1) An isolated colony on a streak plate contains millions (or even billions) of identical cells all arising from one initial cell.

Answer: TRUE
 Section: 6.4
 Bloom's Taxonomy: Knowledge
 ASMcue Outcome: 8.2

Learning Outcome: 6.11

2) Bacterial growth refers to an increase in the numbers of cells in a bacterial culture.

Answer: TRUE

Section: 6.6

Bloom's Taxonomy: Knowledge

Learning Outcome: 6.14

3) Pure cultures can easily be obtained on streak plates, even if the desired bacteria are present in very low concentrations in the initial culture broth.

Answer: FALSE

Section: 6.4

Bloom's Taxonomy: Comprehension

ASMcue Outcome: 8.2

Learning Outcome: 6.12

Global Outcome: 2

4) Agar is used as a solidifying agent in microbiological media since few bacteria can degrade it. Answer: TRUE

Section: 6.3

Bloom's Taxonomy: Knowledge

Learning Outcome: 6.8

5) Laboratory cultivation of obligate anaerobes requires reducing media or special growth chambers filled with inert gases.

Answer: TRUE

Section: 6.3

Bloom's Taxonomy: Knowledge

ASMcue Outcome: 3.3

Learning Outcome: 6.9

6) Most pathogenic bacteria are thermophiles. Answer: FALSE

Section: 6.1

Bloom's Taxonomy: Comprehension

ASMcue Outcome: 3.3

Learning Outcome: 6.1

Global Outcome: 2

7) In performing a ten-fold dilutions series from a sample containing 10,000 bacteria per milliliter, the fourth tube in the dilution series will have 10 cells per milliliter.

Answer: FALSE

Section: 6.6

Bloom's Taxonomy: Analysis
ASMcue Outcome: 7.2
Learning Outcome: 6.16
Global Outcome: 4

8) Turbidity is an indirect measurement of bacterial growth that can be measured using a spectrophotometer.

Answer: TRUE

Section: 6.6

Bloom's Taxonomy: Knowledge

ASMcue Outcome: 8.4

Learning Outcome: 6.18

9) Filtration methods, followed by growth of the bacteria trapped on the filters in growth media, are used to count bacteria present in very low concentrations, such as in lakes and streams. Answer: TRUE

Section: 6.6

Bloom's Taxonomy: Knowledge

ASMcue Outcome: 8.4

Learning Outcome: 6.16

10) Nitrogen-fixing bacteria, such as cyanobacteria, can use atmospheric nitrogen (N₂) for their nitrogen source. Answer: TRUE

Section: 6.1

Bloom's Taxonomy: Knowledge

ASMcue Outcome: 3.1

Learning Outcome: 6.4

6.3 Essay Questions

1) A patient with a heart pacemaker received antibiotic therapy for streptococcal bacteremia (bacteria in the blood). One month later, he was treated for recurrence of the bacteremia. When he returned six weeks later, again with bacteremia, the physician recommended replacing the pacemaker. Why did this cure his condition?

Section: 6.2

Bloom's Taxonomy: Synthesis

Learning Outcome: 6.7

Global Outcome: 8

2) Table 6.3

Medium	Generation Time			
	<i>Escherichia coli</i>	<i>Pseudomonas aeruginosa</i>	<i>Lactobacillus</i>	<i>Nitrobacter</i>
NaCl, NO ₃ ⁻ , MgSO ₄	0	0	0	80
Glucose	100	0	0	0
Glucose, NaCl, PO ₄ ³⁻	56	200	0	0
Glucose, NaCl, PO ₄ ³⁻ , MgSO ₄	43	100	0	0
Glucose, NaCl, PO ₄ ³⁻ , MgSO ₄ , 8 amino acids	28	40	0	0
Glucose, NaCl, PO ₄ ³⁻ , MgSO ₄ , 19 amino acids	25	25	80	0

Bacterial generation times for four different bacterial species were calculated in the media listed in Table 6.3. All media were prepared with pure distilled water and incubated aerobically in the light. Compare and contrast the growth requirements of the four bacteria listed above. Which of the media, if any, are chemically defined?

Section: 6.3

Bloom's Taxonomy: Synthesis

Learning Outcome: 6.8

Global Outcome: 3