Microbiology: Basic & Clinical Principles, 2e **(Norman-McKay)**
Chapter 1 Introduction to Microbiology

1.1 Multiple Choice Questions

1) Which of the following is **not** a microorganism?
A) bacteria
B) archaea
C) fungi
D) mosquito
E) helminth
Answer: D
Chapter/Section: 1.1
Learning Outcome: 1.1
Bloom's Taxonomy: 1-2: Remembering/Understanding

2) When do opportunistic pathogens tend to cause disease?
A) when the host is weakened
B) when the host has recently traveled to a remote area
C) when the host is young
D) when the host is pregnant
E) when the host didn't wash with soap
Answer: A
Chapter/Section: 1.1
Learning Outcome: 1.2
Bloom's Taxonomy: 1-2: Remembering/Understanding

3) Which of the following could be used as evidence for spontaneous generation?
A) Uncovered meat will give rise to maggots.
B) The meat in gauze-covered jars will not give rise to maggots.
C) The broth in Pasteur's S-necked flasks did not spoil.
D) Tilting Pasteur's S-necked flasks did spoil the broth.
E) Flies lay eggs that develop into maggots.
Answer: A
Chapter/Section: 1.1
Learning Outcome: 1.3
Bloom's Taxonomy: 1-2: Remembering/Understanding

4) _____ showed that biogenesis is responsible for the propagation of life.
A) Louis Pasteur
B) Robert Hooke
C) Antonie van Leeuwenhoek
D) Joseph Lister
E) Carl Linnaeus
Answer: A
Chapter/Section: 1.1
Learning Outcome: 1.3
Bloom's Taxonomy: 1-2: Remembering/Understanding

5) Robert Koch helped establish the germ theory of disease by discovering that anthrax was caused by a bacterial microorganism. After he isolated and purified the same bacteria from several diseased animals, what would be the next step in order to show that this bacteria caused anthrax?
A) perform physiological testing
B) introduce the bacteria into a new mouse to see if it established the same infection
C) visualize the bacteria with an electron microscope
D) culture the bacteria on Petri dishes
E) find out if antibiotics treat the diseased animals
Answer: B
Chapter/Section: 1.1
Learning Outcome: 1.4
Bloom's Taxonomy: 1-2: Remembering/Understanding

6) How many principles are there in Koch's postulates of disease?
A) 1
B) 2
C) 3
D) 4
E) 5
Answer: D
Chapter/Section: 1.1
Learning Outcome: 1.4
Bloom's Taxonomy: 1-2: Remembering/Understanding

7) Aseptic technique can be used for all of the following **except**
A) preventing healthcare-acquired infections.
B) safely studying microbes in the laboratory.
C) keeping samples pure for studying.
D) replacing gloves instead of hand washing when time is short.
E) limiting the spread of diseases.
Answer: D
Chapter/Section: 1.1
Learning Outcome: 1.5
Bloom's Taxonomy: 1-2: Remembering/Understanding

8) Which of the following individuals does **not** correctly match with their contribution to microbiology?
A) Ignaz Semmelweis: First developed aseptic techniques to decrease mortality rates from childbed fever
B) Joseph Lister: Developed the first anesthetic solution for use in surgeries
C) Florence Nightingale: Established the use of aseptic techniques in nursing practices
D) Robert Koch: Developed criteria for determining the causative agent of an infectious disease
E) Louis Pasteur: Showed that biogenesis is responsible for the propagation of life
Answer: B
Chapter/Section: 1.1
Learning Outcome: 1.6
Global LO: G2
Bloom's Taxonomy: 3-4: Applying/Analyzing

9) The scientific method starts with a(n)
A) hypothesis.
B) prediction.
C) observation.
D) question.
E) proposal.
Answer: D
Chapter/Section: 1.1
Learning Outcome: 1.7
Global LO: G1
Bloom's Taxonomy: 1-2: Remembering/Understanding

10) Inference-observation confusion occurs when someone
A) jumps to a conclusion.
B) cannot understand your accent.
C) remembers events wrong.
D) lies about what happened.
E) incorrectly assesses a patient.
Answer: A
Chapter/Section: 1.1
Learning Outcome: 1.7
Global LO: G1 | G2
Bloom's Taxonomy: 3-4: Applying/Analyzing

11) _____ predict what happens, while _____ explain how and why something occurs.
A) Theories; laws
B) Hypotheses; conclusions
C) Laws; theories
D) Observations; hypotheses
E) Observations; conclusions
Answer: C
Chapter/Section: 1.1
Learning Outcome: 1.7
Global LO: G1
Bloom's Taxonomy: 1-2: Remembering/Understanding

12) Which of the following is the correct way to type a scientific name?
A) *escherichia coli*
B) Escherichia Coli
C) escherichia coli
D) *Escherichia coli*
E) *Escherichia coli*
Answer: D
Chapter/Section: 1.2
Learning Outcome: 1.10
Bloom's Taxonomy: 1-2: Remembering/Understanding

13) What is the order of the taxonomic hierarchy from least specific to most specific?
A) species, genus, order, family, class, phylum, kingdom, domain
B) domain, kingdom, phylum, class, order, family, genus, species
C) class, order, phylum, kingdom, domain, genus, family, species
D) domain, phylum, order, kingdom, class, family, genus, species
E) domain, order, class, kingdom, phylum, species, family, genus
Answer: B
Chapter/Section: 1.2
Learning Outcome: 1.8
Bloom's Taxonomy: 1-2: Remembering/Understanding

14) All of the following are reasons to classify a new strain of bacteria **except**
A) mutations.
B) gene transfers.
C) take up genetic material from their environment.
D) 50% different genetic material.
E) genetic variant.
Answer: D
Chapter/Section: 1.2
Learning Outcome: 1.9
Bloom's Taxonomy: 1-2: Remembering/Understanding

15) Why can't prokaryotic species be defined as a group of similar organisms that could sexually reproduce together?
A) Bacteria reproduce asexually.
B) Bacteria are all too different to be considered similar.
C) The mating rituals of bacteria have not been studied enough.
D) They can be.
E) We can't see them in enough detail to tell how similar they really are yet.
Answer: A
Chapter/Section: 1.2
Learning Outcome: 1.8 | 1.10
ASM LO: 1.4
Bloom's Taxonomy: 1-2: Remembering/Understanding

16) Normal microbiota are responsible for all of the following **except**
A) training our immune system.
B) producing vitamins for us.
C) helping us digest foods.
D) inducing spontaneous mutations in our genome.
E) impacting our moods and brain functions.
Answer: D
Chapter/Section: 1.2
Learning Outcome: 1.12
ASM LO: 5.4
Bloom's Taxonomy: 1-2: Remembering/Understanding

17) Which of the following does **not** contribute to shifts in our normal microbiota?
A) hormonal changes
B) diet
C) age
D) proper hand-washing technique
E) our general environment
Answer: D
Chapter/Section: 1.2
Learning Outcome: 1.12
ASM LO: 5.4
Bloom's Taxonomy: 1-2: Remembering/Understanding

18) Microbes and humans have evolved a variety of _____ relationships, including _____ where microbes help the host.
A) commensal; mutualism
B) symbiotic; parasitism
C) symbiotic; commensalism
D) dynamic; commensalism
E) symbiotic; mutualism
Answer: E
Chapter/Section: 1.2
Learning Outcome: 1.11
ASM LO: 5.4
Bloom's Taxonomy: 1-2: Remembering/Understanding

19) Carriers of the sickle-cell gene
A) are more likely to die from a malaria infection.
B) are more susceptible to contracting malaria.
C) have a survival advantage in areas where malaria is common.
D) are often found in high concentrations in U.S. cities.
E) experience painful changes in nerve cell shape.
Answer: C
Chapter/Section: 1.2
Learning Outcome: 1.13
Bloom's Taxonomy: 1-2: Remembering/Understanding

20) Which of the following is **true** about bioremediation?
A) Bioremediation never harms the environment.
B) Bioremediation will use genetically-modified organisms to break down the chemicals found in the spill zone.
C) The Environmental Protection Agency documents a handful of chemical spills per year in the United States alone.
D) Antibiotics are used to seed the spill zone to prevent growth of unwanted microbial species.
E) Nitrogen, sulfur, phosphate, and sometimes iron supplements are added to the spill zone to encourage microbial growth.
Answer: E
Chapter/Section: 1.2
Learning Outcome: 1.15
ASM LO: 6.3
Bloom's Taxonomy: 1-2: Remembering/Understanding

21) All of the following are or can be produced by microbes **except**
A) food like chocolate.
B) drugs like penicillin.
C) consumer products like biodegradable plastics.
D) electronics like computer memory.
E) biofuels like diesel.
Answer: D
Chapter/Section: 1.2
Learning Outcome: 1.15
ASM LO: 6.3
Bloom's Taxonomy: 1-2: Remembering/Understanding

22) All of the following may involve biofilms **except**
A) kidney stones.
B) inner ear infections.
C) atherosclerosis.
D) endocarditis.
E) Influenza.
Answer: E
Chapter/Section: 1.2
Learning Outcome: 1.14
Global LO: G2
ASM LO: 5.2
Bloom's Taxonomy: 3-4: Applying/Analyzing

23) When _____ bacteria attach to a surface and begin to replicate, creating multiple layers, sticky communities called _____ may form.
A) planktonic; biofilms
B) pathogenic; quorums
C) plaque; microbiota
D) infectious; flora
E) matrix; cavities
Answer: A
Chapter/Section: 1.2
Learning Outcome: 1.14
ASM LO: 5.2
Bloom's Taxonomy: 1-2: Remembering/Understanding

24) Which of the following statements is **true**?
A) Media for bacterial growth only comes in a few varieties.
B) Picking which type of media format to use depends only on the space available.
C) Picking which type of media to use depends on how much money the researcher is willing to spend.
D) Agar is used as a solidifying agent for bacterial culture media.
E) Scientists were not able to grow bacteria in the lab until the creation of the Petri dish.
Answer: D
Chapter/Section: 1.3
Learning Outcome: 1.16
Bloom's Taxonomy: 1-2: Remembering/Understanding

25) When practicing aseptic culturing techniques, it is important to keep all of the following in mind **except**
A) as long as nothing unintended touches the media, there will be no contamination.
B) the media used to grow the specimen is sterile.
C) all of the instruments and lab ware that directly touch the specimen is sterile.
D) surrounding surfaces are decontaminated before and after handling cultures.
E) gloves and other protecting clothing may be required depending on the specimen being used.
Answer: A
Chapter/Section: 1.3
Learning Outcome: 1.17
Bloom's Taxonomy: 1-2: Remembering/Understanding

26) A biological safety cabinet minimizes the chances of contaminating cultures by all of the following **except**
A) limiting access to inside the cabinet.
B) maintaining a specific flow of filtered air.
C) readily being decontaminated using UV light.
D) regular surface cleaning with an antimicrobial solution.
E) consistent flame sterilization on the inside surfaces.
Answer: E
Chapter/Section: 1.3
Learning Outcome: 1.17
Bloom's Taxonomy: 1-2: Remembering/Understanding

27) The goal of the streak plate technique is to
A) compare all of the colonies on a plate with a mixed culture.
B) visualize all of the colonies on a plate from a pure culture.
C) isolate a pure culture for study from a single colony.
D) spread out a thick layer of bacteria and isolate the bacteria that outcompete the rest.
E) compare how the shape, color, and margin differ in colonies from a pure culture.
Answer: C
Chapter/Section: 1.3
Learning Outcome: 1.18
Bloom's Taxonomy: 1-2: Remembering/Understanding

28) Which of the following can be determined using simple stains?
A) the presence of a waxy cell wall
B) the number and position of flagella
C) the presence of capsules
D) the presence of endospores
E) size, shape, and cellular arrangement
Answer: E
Chapter/Section: 1.3
Learning Outcome: 1.19
ASM LO: 2.3
Bloom's Taxonomy: 1-2: Remembering/Understanding

29) All of the following can make interpreting the Gram stain difficult **except**
A) the culture is between 24 and 48 hours old.
B) testing bacteria that have a waxy cell wall.
C) testing bacteria that are forming endospores.
D) the culture is more than 48 hours old and contains damaged cells.
E) testing bacteria with especially resistant cell walls.
Answer: A
Chapter/Section: 1.3
Learning Outcome: 1.20
Bloom's Taxonomy: 1-2: Remembering/Understanding

30) The acid-fast stain is an important diagnostic tool for detecting the causative agent(s) of
A) gonorrhea.
B) tuberculosis and leprosy.
C) plague.
D) malaria.
E) Lyme disease and necrotizing fasciitis.
Answer: B
Chapter/Section: 1.3
Learning Outcome: 1.21
Bloom's Taxonomy: 1-2: Remembering/Understanding

31) Which of the following statements is **true** about the decolorizing step for the acid-fast stain?
A) The decolorizing step is the differentiating step.
B) Over-decolorizing can lead to false-positive results.
C) Acetone-alcohol solution is the decolorizing agent.
D) Because acid-fast bacteria have a waxy cell wall that resists decolorization by the acetone-alcohol rinse, they appear a deep blue at the end of the procedure.
E) Non-acid-fast bacteria appear bright pink-red at the end of the procedure.
Answer: A
Chapter/Section: 1.3
Learning Outcome: 1.21
Global LO: G2
Bloom's Taxonomy: 1-2: Remembering/Understanding

32) Which of the following statements about bright field microscopy is **true**?
A) Bright field microscopy is great for seeing living samples.
B) Dark field, phase contract, and differential interference contract microscopy are better for observing dead samples.
C) Bright field microscopy is the simplest and most common form of microscopy.
D) Bright field microscopy is able to see specimens without natural coloration.
E) Bright field microscopy has the sample appear as a brighter contrasting image on a dark background.
Answer: C
Chapter/Section: 1.3
Learning Outcome: 1.22
ASM LO: 2.1
Bloom's Taxonomy: 1-2: Remembering/Understanding

33) Which of the following statements is **false**?
A) Resolution is the ability to distinguish two distinct points as separate.
B) Immersion oil is used to get a better resolution at high-power magnifications.
C) Ultimately, the resolving power of bright field microscopes is limited by the wavelength of visible light.
D) Immersion oil has a lower refractive index than the glass slide to help increase sample clarity.
E) Immersion oil channels as much light as possible up through the objective lens instead of being bent.
Answer: D
Chapter/Section: 1.3
Learning Outcome: 1.23
ASM LO: 2.1
Bloom's Taxonomy: 1-2: Remembering/Understanding

34) Which of the following statements is **false**?
A) Scanning electron microscopy provides information about surface structures.
B) Transmission electron microscopy provides information about internal structures.
C) Immunofluorescence is when fluorochromes bind to a specific target and fluoresce after exposure to UV light.
D) Fluorescence microscopy is when fluorochromes stain a sample so it will fluoresce when exposed to UV light.
E) Fluorochromes can be natural or synthetic.
Answer: C
Chapter/Section: 1.3
Learning Outcome: 1.24
ASM LO: 2.1
Bloom's Taxonomy: 1-2: Remembering/Understanding

35) Why do electron microscopes have a better resolution than light microscopes?
A) An electron beam has a wavelength of about 800 nm, and resolution improves with larger wavelengths.
B) An electron beam has a wavelength of about 1 nm, and resolution improves with smaller wavelengths.
C) The lenses used to focus the electron beam are more adjustable than the ones in a light microscope.
D) The lenses, knobs, and strength of the electron beam can all be highly controlled, which also explains why electron microscopes are so expensive.
E) The additional steps necessary to prepare the sample for viewing provide the improved resolution.
Answer: B
Chapter/Section: 1.3
Learning Outcome: 1.24
ASM LO: 2.1
Bloom's Taxonomy: 1-2: Remembering/Understanding

36) Louis Pasteur's S-necked flask experiment strengthened the theory of
A) spontaneous generation.
B) biogenesis.
C) abiogenesis.
D) evolution.
E) specific gravity.
Answer: B
Chapter/Section: 1.1
Learning Outcome: 1.3
Bloom's Taxonomy: 1-2: Remembering/Understanding

37) For which of the following situations could Koch's Postulates be used?
A) Determining that an outbreak of measles in a school could be traced to someone who had recently traveled to an area where measles was endemic.
B) Studying the relationship between diet and exercise on rates of heart disease in an elderly population.
C) Determining whether a vaccine could prevent the spread of influenza in a population.
D) Determining the specific genus and species of the bacterial organism that causes cholera.
E) Determining how a breakdown in proper aseptic technique caused an outbreak of *C. difficile* in a local hospital.
Answer: D
Chapter/Section: 1.1
Learning Outcome: 1.4
Global LO: G2
Bloom's Taxonomy: 3-4: Applying/Analyzing

38) Which of the following type of microbe is always unicellular?
A) fungi
B) helminths
C) protists
D) bacteria
E) viruses
Answer: D
Chapter/Section: 1.2
Learning Outcome: 1.8
Bloom's Taxonomy: 1-2: Remembering/Understanding

39) All of the following correctly describe a bacterial colony **except**
A) All of the cells in a colony presumably arose from a single parent cell and are clones of one another.
B) The best way to produce a colony is the streak plate method.
C) A variation in size between different colonies on a streak plate indicates that the culture is contaminated.
D) A pure culture can be obtained from a mixed culture by isolating bacterial colonies.
E) Different species of bacteria will produce distinctive colonies that can aid in identification.
Answer: C
Chapter/Section: 1.3
Learning Outcome: 1.18
ASM LO: 8.2
Bloom's Taxonomy: 3-4: Applying/Analyzing

40) A student was in a hurry to finish lab and forgot to apply the final counterstain (safranin) during a Gram stain procedure. Which statement below best describes the expected result when the stain is viewed under the microscope?
A) There would be no effect on Gram-positive cells, but Gram-negative cells would not be visible.
B) There would be no effect on Gram-negative cells, but Gram-positive cells would not be visible.
C) Any Gram-negative cells in the stain would appear to be Gram-positive.
D) Any Gram-positive cells in the stain would appear to be Gram-negative.
E) All cells in the stain would be bright pink.
Answer: A
Chapter/Section: 1.3
Learning Outcome: 1.20
Global LO: G2
ASM LO: 2.1
Bloom's Taxonomy: 3-4: Applying/Analyzing

41) A researcher needs to view the details of the entry of a virus into a host cell. Which of the following microscopic techniques would be most appropriate?
A) Bright field light microscopy
B) Dark field microscopy
C) Transmission electron microscopy
D) Scanning electron microscopy
E) Fluorescence microscopy
Answer: C
Chapter/Section: 1.3
Learning Outcome: 1.24
Bloom's Taxonomy: 3-4: Applying/Analyzing

1.2 True/False Questions

1) Robert Hooke refined earlier versions of the microscope and became the first to see bacteria.
Answer: FALSE
Chapter/Section: 1.1
Learning Outcome: 1.4
Bloom's Taxonomy: 1-2: Remembering/Understanding

2) Florence Nightingale investigated processes for aseptic surgery and her work in the 1860s proved that sterilizing instruments, and sanitizing wounds with carbolic acid encouraged healing and prevented pus formation.
Answer: FALSE
Chapter/Section: 1.1
Learning Outcome: 1.6
Bloom's Taxonomy: 1-2: Remembering/Understanding

3) Only a small minority of microbes are human pathogens.
Answer: TRUE
Chapter/Section: 1.2
Learning Outcome: 1.11
Bloom's Taxonomy: 1-2: Remembering/Understanding

4) Proper hand-washing technique can disrupt normal microbiota.
Answer: FALSE
Chapter/Section: 1.2
Learning Outcome: 1.12
Bloom's Taxonomy: 1-2: Remembering/Understanding

5) Biofilms allow microbes to coordinate responses within an environment, making the community much more durable than single free-floating bacteria.
Answer: TRUE
Chapter/Section: 1.2
Learning Outcome: 1.14
ASM LO: 5.2
Bloom's Taxonomy: 1-2: Remembering/Understanding

6) Fixation adheres the sample to the slide, so that it is not as easily washed away during the staining process, but does not kill most of the cells in the specimen.
Answer: FALSE
Chapter/Section: 1.3
Learning Outcome: 1.19
Bloom's Taxonomy: 1-2: Remembering/Understanding

7) Simple staining techniques use only one dye.
Answer: TRUE
Chapter/Section: 1.3
Learning Outcome: 1.19
Bloom's Taxonomy: 1-2: Remembering/Understanding

8) Knowing the Gram property of a specimen has important clinical implications, including potential pathogenic features of the organism, and what antibiotics might be most effective in combating it.
Answer: TRUE
Chapter/Section: 1.3
Learning Outcome: 1.20
ASM LO: 2.2
Bloom's Taxonomy: 1-2: Remembering/Understanding

9) Fungi are always unicellular.
Answer: FALSE
Chapter/Section: 1.1
Learning Outcome: 1.1
Bloom's Taxonomy: 1-2: Remembering/Understanding

1.3 Essay Questions

1) Explain the differences between a hypothesis, law, and theory.
Answer: A hypothesis is based on prior experience or observation, and is proposed as a potential answer to a specific question. A law is a precise statement, or mathematical formula, that predicts a specific occurrence. Laws only hold true under carefully defined and limited circumstances. By contrast, a theory is a hypothesis that has been proven through many studies with consistent, supporting conclusions. Laws predict what happens, while theories explain how and why something occurs. Unlike a hypothesis, which focuses on a specific problem, theories are comprehensive bodies of work that are useful for making generalized predictions about natural phenomena. Theories unite many different hypotheses and laws.
Chapter/Section: 1.1
Learning Outcome: 1.7
Global LO: G8
Bloom's Taxonomy: 1-2: Remembering/Understanding

2) Explain how disruptions in normal microbiota can lead to infections.
Answer: When an antibiotic is used, it may kill many types of benign resident bacteria along with the pathogen being targeted. With normal microbiota reduced, opportunistic pathogens are able to establish infections. A common example of this is when a woman takes antibiotics to treat a urinary tract infection (UTI), only to develop a vaginal yeast infection soon after the antibiotic therapy concludes. The yeast *Candida albicans* is an opportunistic pathogen that is usually present in the vagina. Its growth is kept in check by the normal microbiota of the vagina. Thus, when the vaginal normal microbiota is disrupted, the yeast has an opportunity to thrive and cause symptoms. Similarly, diarrhea is a common side effect of antibiotic therapies, likely due to how our gut microbiome is affected.
Chapter/Section: 1.2
Learning Outcome: 1.12
Global LO: G8
ASM LO: 5.4
Bloom's Taxonomy: 1-2: Remembering/Understanding

3) Explain the differences between basic and acidic dyes and how they are used.
Answer: Basic dyes are mildly basic on the pH scale. Being basic means they are positively charged, resulting in the stain being attracted to the negatively charged cell surface of microbes and easily entering cells. Frequently used basic dyes include methylene blue, crystal violet, safranin, and malachite green. Occasionally acidic dyes, such as nigrosin or India ink, are also used. Acidic dyes are negatively charged, so they do not easily enter cells. They stain the background of a specimen in a technique called negative staining. An advantage of negative staining is that it doesn't require heating or chemical fixation, and the dye is not absorbed by the sample. This means the sample has a more true-to-life appearance, with fewer distortions of delicate cellular features.
Chapter/Section: 1.3
Learning Outcome: 1.19
Global LO: G8
Bloom's Taxonomy: 1-2: Remembering/Understanding

4) Discuss Louis Pasteur's S-necked flask experiment. Specifically, *how* did he disprove spontaneous generation? What were his positive and negative experimental controls?
Answer: Louis Pasteur used S-necked flasks with liquid broth that had been sterilized. He then set up three different experimental groups. For the first group (negative control), he just left the S-necked flasks with the broth for an extended period of time. No microbes ever grew in the flask. For the second group (positive control), he broke the opening at the top and dust was able to settle into the broth. Microbes grew in this flask very quickly. For the third experimental group, he first let the flasks sit for an extended period of time and observed that no microbes grew. However, he then tipped the flask just enough that the broth came in contact with dust that had settled in the S-neck over time. Just this brief contact was enough for microbes to start growing in the flask. This proved that microbes from the air, and not just the broth itself, were required in order for cells to start growing, even if the broth had the perfect conditions for growth. This effectively disproved spontaneous generation, and proved biogenesis, the theory that only existing living organisms can give rise to new living cells.
Chapter/Section: 1.1
Learning Outcome: 1.3
Global LO: G8
Bloom's Taxonomy: 3-4: Applying/Analyzing