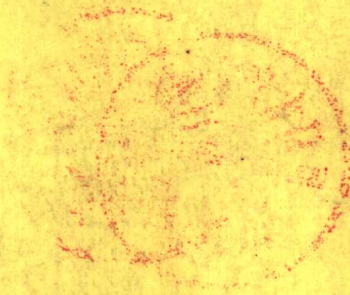

The National Medical Series for Independent Study

microbiology

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Preface

Microbiology is the result of the collective experience of three authors, which was accumulated while teaching microbiology at the California College of Medicine of the University of California, Irvine, and George Washington University Medical Center. The authors wish to stress that this volume has been developed as a review book, and it is not intended to be used as a textbook of microbiology. Because microbiology is a fast-moving discipline, it is impossible to keep a volume of this type up-to-the-minute. The authors have attempted to present the latest well-established information at the time of printing. We hope that students will find *Microbiology* to be a useful study guide as well as a concise review of this broad and exciting field.

David T. Kingsbury

Introduction

Microbiology is one of seven basic science review books in a series entitled, *The National Medical Series for Independent Study*. This series has been designed to provide students and house officers, as well as physicians, with a concise but comprehensive instrument for self-evaluation and review within the basic sciences. Although *Microbiology* would be most useful for students preparing for the National Board of Medical Examiners examinations (Part I, FLEX, VQE, and ECFMG), it should also be useful for students studying for course examinations. These books are not intended to replace the standard basic science texts, but, rather, to complement them.

The books in this series present the core content of each basic science area using an outline format and featuring a total of 300 study questions. The questions are distributed throughout *Microbiology* at the end of each chapter and in a pretest and post-test. In addition, each question is accompanied by the correct answer, a paragraph-length explanation of the correct answer, and specific reference to the outline points under which the information necessary to answer the question can be found.

We have chosen an outline format to allow maximum ease in retrieving information, assuming that the time available to the reader is limited. Considerable editorial time has been spent to ensure that the information required by all medical school curricula has been included and that each question parallels the format of the questions on the National Board examinations. We feel that the combination of the outline format and board-type study questions provides a unique teaching device.

We hope you will find this series interesting, relevant, and challenging. The authors, as well as the John Wiley and Harwal staffs, welcome your comments and suggestions.

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Pretest

QUESTIONS

Directions: Each question below contains five suggested answers. Choose the **one best** response to each question.

1. Infectious virus can be isolated from the stool for 3 or more weeks following infection with which of the following viruses?
 - (A) Herpes simplex virus
 - (B) Poliovirus
 - (C) Smallpox virus
 - (D) Influenza virus
 - (E) Hepatitis B virus
2. Venereal transmission occurs in all of the following conditions EXCEPT
 - (A) toxic shock syndrome (TSS)
 - (B) genital herpes
 - (C) chancroid
 - (D) granuloma inguinale
 - (E) lymphogranuloma venereum
3. Phenotypic mixing occurs between
 - (A) closely related naked capsid viruses
 - (B) naked capsid and enveloped viruses
 - (C) closely related DNA viruses
 - (D) all viruses that infect the same cell
 - (E) only DNA and RNA viruses
4. Common skin warts (verrucae) in humans are caused by the human wart virus. All of the following statements describe properties of the human wart virus EXCEPT
 - (A) it has a papovavirus morphology
 - (B) it replicates well in human and monkey tissue cultures
 - (C) it causes the most common small DNA virus infection of humans
 - (D) its incubation period is from 1 to 6 months
 - (E) the virus is spread by direct contact or autoinoculation
5. The major cause of transfusion-associated hepatitis in the United States is
 - (A) hepatitis A virus
 - (B) hepatitis B virus
 - (C) non-A, non-B hepatitis virus
 - (D) cytomegalovirus
 - (E) Epstein-Barr virus
6. The most clinically useful serologic test for confirming a diagnosis of syphilis is the
 - (A) fluorescent treponemal antibody-absorbed serum test
 - (B) fluorescent treponemal antibody test
 - (C) Venereal Disease Research Laboratory (VDRL) test
 - (D) *Treponema pallidum* immobilization test
 - (E) Wassermann antibody cardiolipin test

7. What is the most common method of introducing microorganisms into the respiratory tract?

- (A) Aspiration of dust particles
- (B) Contact with contaminated fomites
- (C) Aerosolization
- (D) Animal contact
- (E) Intimate human contact

8. A diabetic patient receiving intravenous therapy for dehydration develops fungemia caused by *Candida albicans*. This infection is probably the result of

- (A) iatrogenic infection
- (B) nosocomial infection
- (C) acquired immune deficiency syndrome (AIDS)
- (D) parenteral fluid contamination
- (E) poor therapeutic technique

9. Rabies is a member of which of the following virus groups?

- (A) Arbovirus
- (B) Rhabdovirus
- (C) Myxovirus
- (D) Togavirus
- (E) Arenavirus

10. Bacteria are simple genetic units with all of the following properties EXCEPT

- (A) they are haploid
- (B) their genetic material is organized into a single chromosome
- (C) their DNA has intervening sequences (introns) in almost all genes
- (D) they use the same genetic code as eukaryotic cells
- (E) their genotypes and phenotypes are the same

11. The retroviruses have many unique biologic and biochemical features. All of the following are properties of the retroviruses EXCEPT

- (A) they are genetically diploid
- (B) the particles contain an RNA-dependent DNA polymerase
- (C) they require integration into the host genome for proper replication
- (D) the RNA has minus polarity
- (E) the retroviral group antigens are highly reactive between strains

12. The antibiotic erythromycin can be described as

- (A) belonging to the aminoglycoside class of drugs
- (B) inhibiting the translocation reaction on ribosomes
- (C) binding to bacterial cell membranes
- (D) inhibiting DNA-dependent RNA polymerase
- (E) causing miscoding during translation in protein synthesis

13. Two antibody clones that share an identical amino acid sequence at their antigen combining site are said to share

- (A) epitope
- (B) isotype
- (C) idiotype
- (D) heavy chain
- (E) Fc region

14. The rat flea is an important vector in the transmission of which of the following diseases?

- (A) Ulceroglandular tularemia
- (B) Brucellosis
- (C) Pasteurellosis
- (D) Dengue
- (E) Bubonic plague

15. What is the initial step in the process of infection?

- (A) Colonization of host tissue by the invading microorganism
- (B) Multiplication of the microbe on the surface of host cells
- (C) Adherence of the microorganism to susceptible host cells
- (D) Penetration of skin epithelial cells by the invading microorganism
- (E) Acquisition of specific nutrients by the potential pathogenic microbe

16. The most common manifestation of infection in the hospitalized or immunocompromised patient is

- (A) chills
- (B) cough
- (C) nausea
- (D) myalgia
- (E) fever

17. The defective interfering (DI) particles of vesicular stomatitis virus have all of the following characteristics EXCEPT

- (A) the presence of all of the normal proteins found in a nondefective virus
- (B) the ability to replicate by themselves in monkey kidney cells
- (C) a shortened RNA genome
- (D) the ability to alter the course of infection by normal virus particles
- (E) a sedimentation constant different from that of the wild-type virus

18. When viewed in the electron microscope, gram-positive and gram-negative bacteria are differentiated based on which of the following ultrastructural properties?

- (A) Thickness of the peptidoglycan layer of the cell wall
- (B) Thickness of the cytoplasmic membrane
- (C) Size and position of the nucleoid
- (D) Number and placement of the flagella
- (E) Number of intracellular ribosomes

19. Which of the following factors represents the major difference between bacteremia and septicemia?

- (A) Etiologic agent
- (B) Overt clinical symptomatology
- (C) Diagnostic methods
- (D) Selected therapy
- (E) Potential complications

20. Which of the following diseases is characterized by the presence of Negri bodies in host cells?

- (A) Rabies
- (B) Infectious mononucleosis
- (C) Congenital rubella
- (D) Mumps
- (E) Varicella

21. The term capsomere refers to the

- (A) unique 5' terminal structure found on minus-strand viruses
- (B) protein and lipid that enclose the nucleocapsid
- (C) glycosylated appendages protruding from the envelope of the virus
- (D) protein subunits that form the capsid
- (E) internal core protein

22. All of the following statements describe bacterial growth EXCEPT

- (A) bacterial growth is exponential and not arithmetic
- (B) bacteria begin to grow immediately when placed in fresh growth medium
- (C) bacterial growth rates are regulated by the nutritional environment
- (D) bacterial growth rates are regulated by the temperature
- (E) after a period of maximal growth bacteria begin to slow their growth and eventually die and are lysed

23. Which of the following gram-negative rods is the leading cause of urinary tract infection in otherwise healthy individuals?

- (A) *Pseudomonas aeruginosa*
- (B) *Klebsiella pneumoniae*
- (C) *Serratia marcescens*
- (D) *Escherichia coli*
- (E) *Proteus mirabilis*

24. The total number of viral particles in a suspension of animal viruses can best be determined through

- (A) direct measurement of viral plaques
- (B) direct infectivity assays
- (C) quantitative electron microscopy
- (D) quantitative hemagglutination
- (E) none of the above

25. Which of the infections listed below is a complication arising from vaccination against smallpox?

- (A) Eczema vaccinatum
- (B) Subacute sclerosing panencephalitis
- (C) Giant cell pneumonia
- (D) Orchitis
- (E) None of the above

26. Contaminated wound dressings are sterilized best by

- (A) boiling in water for 1 hour
- (B) immersion in a quaternary ammonium compound
- (C) autoclaving for 20 minutes
- (D) exposure to a germicidal ultraviolet light
- (E) soaking in 70 percent ethanol for 2 hours

27. The most common etiologic agent of bacterial pneumonia is

- (A) *Staphylococcus aureus*
- (B) *Klebsiella pneumoniae*
- (C) *Streptococcus pyogenes*
- (D) *Streptococcus pneumoniae*
- (E) *Mycoplasma pneumoniae*

Directions: Each question below contains four suggested answers of which **one or more** is correct. Choose the answer

- A if 1, 2, and 3 are correct
- B if 1 and 3 are correct
- C if 2 and 4 are correct
- D if 4 is correct
- E if 1, 2, 3, and 4 are correct

28. Bacteria that comprise the indigenous flora of humans include

- (1) *Bacteroides fragilis*
- (2) *Escherichia coli*
- (3) *Pseudomonas aeruginosa*
- (4) *Bacteroides melaninogenicus*

29. Antimicrobial therapy is effective in the treatment of

- (1) congenital syphilis
- (2) primary syphilis
- (3) secondary syphilis
- (4) tertiary syphilis

30. Of the following organisms, those that typically cause a granulomatous infection of the lung in otherwise healthy individuals include

- (1) *Histoplasma capsulatum*
- (2) *Mucor racemosus*
- (3) *Blastomyces dermatitidis*
- (4) *Aspergillus niger*

31. Effective vaccines are available for infections caused by which of the following microorganisms?

- (1) *Haemophilus influenzae* type b
- (2) *Francisella tularensis*
- (3) *Bordetella pertussis*
- (4) *Haemophilus ducreyi*

32. True statements concerning genetic transformation include

- (1) it is sensitive to the presence of DNase in the transforming buffer
- (2) it has been observed in both gram-positive and gram-negative bacteria
- (3) it requires that the bacteria be in a state of competence
- (4) it involves the packaging and transfer of the DNA by a bacteriophage

33. The epidemiology of rabies is complex and involves a variety of animals, including

- (1) foxes
- (2) skunks
- (3) bats
- (4) cattle

34. True statements about the pathogenicity of *Neisseria gonorrhoeae* include

- (1) *N. gonorrhoeae* strains that cause urogenital disease usually require arginine, uracil, and hypoxanthine for growth
- (2) gonococci isolated from patients with disseminated disease are very sensitive to penicillin and resistant to the bactericidal action of serum
- (3) most gonorrhea in the United States is caused by strains of *N. gonorrhoeae* that carry a plasmid responsible for the production of β -lactamase
- (4) the ability of gonococci to attach to urethral epithelium is due to the presence of pili on the infecting bacteria

35. Which of the following factors may be important in the development of viral pneumonia?

- (1) Underlying illness
- (2) Hospitalization
- (3) Cell-mediated immunity
- (4) The age of the patient

36. The erythrogenic toxins of *Streptococcus pyogenes* can be described as

- (1) existing in three distinct serologic forms
- (2) being pyrogenic to humans
- (3) causing the signs and symptoms of scarlet fever
- (4) producing the sequela of acute glomerulonephritis

37. The factors that eventually enabled public health workers to eradicate smallpox include

- (1) its extremely limited geographic distribution in the Indian subcontinent
- (2) the antigenic identity of the two major forms as well as their cross-reactivity with the vaccine strain
- (3) the relative instability of the virus
- (4) the absence of an animal reservoir, with all infections limited to humans

38. The presence of viruses in an infected cell culture may be detected through

- (1) the cytopathic changes in the cultured cells
- (2) the ability of the cytoplasmic membrane of the infected cells to adsorb red blood cells
- (3) the presence of viral proteins in the infected cell monolayers
- (4) the altered nutritional requirements of the virus-infected cells

39. True statements about tetanus include

- (1) administration of tetanus antitoxin results in long-lived immunity
- (2) recovery from tetanus offers no protection against future infection
- (3) tetanus toxoid is isolated from the culture filtrates of *Clostridium tetani*
- (4) active immunization of pregnant women with tetanus toxoid induces immunity in the fetus

40. Procedures that are considered to be useful in the diagnosis of gonorrhea include

- (1) Gram stain of urethral exudates from males
- (2) culture of anal tissue from homosexual males
- (3) culture of tissue from the cervical os
- (4) Gram stain of anal tissue swabbed from asymptomatic females

41. The classification of a microorganism reveals a great deal about the organism because

- (1) classification reveals the historic background of the organism
- (2) classification is based on readily observable properties of significance to the organism
- (3) pathogenic bacteria are grouped in different genera than nonpathogenic bacteria
- (4) the primary criterion for classification, cell wall structure, is a very significant factor clinically

42. An elderly man is found to have a very high level of immunoglobulin in his serum. Which of the listed data would argue against a diagnosis of lymphoid malignancy?

- (1) Electrophoretic data suggest that the immunoglobulin is polyclonal
- (2) The patient is anergic to skin test antigens
- (3) Both κ and λ light chains are present in similar amounts
- (4) Mature plasma cells are noted in the bone marrow

43. Sexually transmitted treponemal diseases include

- (1) yaws
- (2) pinta
- (3) bejel
- (4) syphilis

44. Bacterial meningitis frequently is caused by which of the following microorganisms?

- (1) *Haemophilus influenzae*
- (2) *Streptococcus pneumoniae*
- (3) *Neisseria meningitidis*
- (4) *Escherichia coli*

Directions: The groups of questions below consist of lettered choices followed by several numbered items. For each numbered item select the **one** lettered choice with which it is **most** closely associated. Each lettered choice may be used once, more than once, or not at all.

Questions 45–48

Pseudomonas aeruginosa produces several factors that affect the pathogenesis of human disease. Match the appropriate pathogenic actions with the products of this organism.

- (A) Phospholipase C
 - (B) Protease
 - (C) Pyocyanin
 - (D) Enterotoxin
 - (E) Exotoxin A
45. Kills cultured mammalian cells
 46. Hydrolyzes connective tissue
 47. Inhibits amino acid uptake
 48. Kills other bacteria

Questions 49–52

For each test listed below, select its most appropriate medical use.

- (A) Diagnostic
 - (B) Epidemiologic
 - (C) Both
 - (D) Neither
49. A positive delayed-type hypersensitivity (DTH) skin test for tuberculosis
 50. A positive latex agglutination test for cryptococcal capsular polysaccharide
 51. The radioimmunoassay detection of antibodies induced by antigens of *Candida* species
 52. A positive Venereal Disease Research Laboratory (VDRL) test

Questions 53–56

The following statements describe characteristics of spirochetal disease. Match each statement with the disease it best describes.

- (A) Syphilis
 - (B) Yaws
 - (C) Both
 - (D) Neither
53. The disease is characterized by primary, secondary, and tertiary stages
 54. The etiologic agent is a fine, regular spiral with an axial filament
 55. The disease is venereally transmitted
 56. The progressive symptoms frequently include facial disfigurement

Questions 57–60

Match each statement to the obligate intracellular bacteria that it best describes.

- (A) Chlamydiae
 - (B) Rickettsiae
 - (C) Both
 - (D) Neither
57. Energy in the form of adenosine triphosphate (ATP) is required for these bacteria to enter the susceptible host cell
 58. These bacteria contain cell wall constituents similar to those of gram-negative bacteria
 59. These bacteria can produce human disease after a long latent period
 60. Transmission of these bacteria is by close personal contact

ANSWERS AND EXPLANATIONS

1. The answer is B. (Chapter 22 III C 3 b) Poliovirus is a typical member of the enterovirus group. The virus spreads via the fecal-oral route rather than the respiratory route used by the other viruses listed. Virus replication occurs in the epithelial lining of the gastrointestinal tract, which leads to the virus' release into the gut and subsequent excretion in the feces.

2. The answer is A. (Chapter 29 III C) Toxic shock syndrome (TSS) is caused by toxin-producing *Staphylococcus aureus*. The bacteria are believed to be introduced into the vagina by hand contamination of expandable tampons made of synthetic materials. There is no evidence that the etiologic agent is transmitted venereally. Chancroid, lymphogranuloma venereum, and granuloma inguinale usually are transmitted venereally; primary genital herpes may be acquired through sexual contact.

3. The answer is A. (Chapter 19 VI B 3) Phenotypic mixing is the result of the mixing of the capsid proteins of very closely related viruses (e.g., polio- and coxsackieviruses). The interchange of the proteins has only minimal structural effects.

4. The answer is B. (Chapter 21 I B) The human wart virus is the most common papovavirus infection of humans. The virus is a typical papovavirus; however, it does not grow in tissue culture of any type. All of the information currently available about these viruses has been derived from viruses that were isolated from human wart tissue.

5. The answer is C. (Chapter 23 I G 3) Because of the availability of good diagnostic tests for hepatitis B virus and hepatitis A virus, most blood supplies and blood donors are screened carefully for these viruses. As a result, the incidence of transfusion-associated disease related to these two viruses is much lower than that related to non-A, non-B hepatitis viruses, which cannot be detected by normal screening procedures. Both cytomegalovirus and Epstein-Barr virus have been associated with cases of hepatitis but are rare in this disease.

6. The answer is A. (Chapter 6 III C 1 b) The fluorescent treponemal antibody-absorbed serum test is highly specific and sensitive. A positive test is diagnostic for syphilis. This test is more specific than the fluorescent treponemal antibody test because serum antibodies against nonpathogenic treponemes have been absorbed out of the patient's serum. The *Treponema pallidum* immobilization test is specific for *T. pallidum*, but the test has proved to be too cumbersome for routine clinical laboratory use. The detection of Wassermann antibodies by either the Venereal Disease Research Laboratory (VDRL) test or the rapid plasma reagin test is not diagnostic for syphilis. Other infectious and noninfectious diseases also induce the formation of Wassermann antibodies.

7. The answer is C. (Chapter 7 I B 1) Inhalation of aerosolized microorganisms is the most common method of introducing pathogens into the respiratory tract. The microorganisms contaminate droplets that usually are smaller than $10\ \mu$ in diameter; droplets of this size are not filtered by hair in the external nares. Only occasional microbial infections of the respiratory tract are caused by the inhalation of dust particles that have been contaminated, by aspiration of microbes colonizing the oropharyngeal area, by inanimate objects contaminated with pathogens (i.e., fomites), or by intimate contact.

8. The answer is A. (Chapter 31 II B 10; Table 31-1) The skin and mucous membranes of diabetic patients often are colonized by *Candida albicans*; these patients are at risk for developing an iatrogenic infection. Although the described patient's infection also is nosocomial in origin, it is more specifically iatrogenic in that it was initiated by medical treatment and involved the patient's indigenous flora. The intravenous catheter provides a break in the defensive barrier of the skin, allowing for entry of the opportunistic pathogen into the bloodstream.

9. The answer is B. (Chapter 22 IV A-B) Rabies is a bullet-shaped virus that consists of a single helical strand of ribonucleoprotein containing a single minus-strand RNA. The virus carries its own transcriptase and, therefore, clearly is a rhabdovirus.

10. The answer is C. (Chapter 3 I B 4) Bacterial DNA is transcribed into both monocistronic and polycistronic messenger RNA (mRNA) in the cytoplasm without the need for any subsequent processing. This simple mechanism is possible because of the absence of introns (intervening sequences) and the absence of a nuclear membrane.

11. The answer is D. (Chapter 23 III E) The retroviruses are unique in their diploid genetic structure, with two identical RNA molecules per virion. In order to initiate an effective infection, the virion-associated reverse transcriptase must produce a double-stranded DNA copy of the viral RNA, and that

copy must be integrated into the host genome. Infectious virus then is produced from the integrated copy. The various viral antigens are made from messenger RNA (mRNA) produced from the DNA copy, and these antigens include both group-specific and host-specific reactive antigens. The viral RNA has plus polarity.

12. The answer is B. (Chapter 4 II C 4) Erythromycin is the most widely used macrolide antibiotic. This antibiotic binds to the 50S subunit of the ribosome and prevents translocation of amino acids during protein synthesis by inhibiting transpeptidyltransferase activity.

13. The answer is C. (Chapter 5 II A, B) The idiotype of an antibody molecule is a reflection of the structure of the molecule at the combining site. The prime determinant of this structure is the amino acid sequence. The isotype is determined by the heavy chain class present in the antibody molecule. The antibody product of an individual cell may shift from one isotype to another. The Fc region is determined by the heavy chain class of the antibody molecule at the end distant from the antigen combining site. Epitopes are specific regions on an antigen molecule.

14. The answer is E. (Chapter 12 III B 3 a) The rat flea is the primary vector of bubonic plague. A unique process occurs during the transmission of bubonic plague from an infected rodent to humans. The rat flea takes a blood meal from an infected rodent and acquires the bacteria. *Yersinia pestis* produces an enzyme that reacts with an intestinal enzyme of the flea and causes the blood acquired during the feeding to coagulate. This coagulated blood obstructs the gastrointestinal tract of the flea, and it is unable to feed. The starving flea becomes indiscriminant in its selection of a host and will attack humans in an attempt to acquire a blood meal. When the flea bites its human victim, it regurgitates because of the obstruction, and bacteria enter the wound. *Y. pestis* disseminates from this site of inoculation to the regional lymph nodes, which become swollen and tender. These buboes may suppurate and drain.

15. The answer is C. (Chapter 7 I A) There are four basic steps in the successful invasion of host cells by a microorganism. The initial step in this process is adherence or adhesion of the microbe to the susceptible cell. This adherence is affected both by microbial factors such as pili and by host cell factors such as receptor sites. Adherence also can be inhibited by the presence of other microorganisms blocking receptor sites. Successful adherence then may lead to the additional steps in the pathogenic process. The subsequent steps are colonization, multiplication, and penetration.

16. The answer is E. (Chapter 31 I B) Specific signs and symptoms of infection in the hospitalized or immunocompromised patient depend upon the size of the inoculum and the site of the infection. However, the initial and most common manifestation of an ongoing infectious process is fever. In the immunosuppressed patient, the rise in temperature may be slight but should serve as a warning signal for infection.

17. The answer is B. (Chapter 19 VI B 4 b) The defective interfering (DI) particles of the vesicular stomatitis virus have all of the proteins found in wild-type virus but have a truncated RNA, thereby leading to the formation of shortened virus particles. The DI particles are unable to replicate without the help of the wild-type particle with which they interfere during growth.

18. The answer is A. (Chapter 2 II A 2) The bacterial cell wall is the primary determinant of the Gram reaction. The cell walls of gram-positive and gram-negative bacteria differ in two ways: The peptidoglycan layer is thick in gram-positive bacteria and thin in gram-negative bacteria, and a lipopolysaccharide outer layer is present in gram-negative bacteria and absent in gram-positive organisms. The peptidoglycan layer is very electron dense, and the heavier layer present in gram-positive bacteria is readily apparent in the electron microscope.

19. The answer is B. (Chapter 26 I A, B) Although the terms bacteremia and septicemia frequently are used interchangeably, these conditions are distinctly different. Bacteremia simply means the presence of bacteria in the bloodstream. It is recognized now that bacteremia occurs daily with no clinical significance. Septicemia more correctly describes the presence of bacteria in the bloodstream, with resultant overt clinical symptomatology.

20. The answer is A. (Chapter 22 IV D) Intracellular inclusion bodies composed of high concentrations of viral particles or viral cores occur with several different viral infections. One type of intracellular inclusion, the Negri body, is characteristic of and has become the common marker for rabies infection. The presence of these inclusions in the brain tissue of an animal or individual suspected of having rabies is diagnostic.

21. The answer is D. (Chapter 18 III A 2) The capsomere is the basic building block that aggregates to

form the viral coat or capsid. The capsomere may be composed of several individual polypeptides or protomers. The protomers represent the product of a single viral gene, and in most viruses several different protomers associate to form a capsomere.

22. The answer is B. (Chapter 2 IV B 1 a) Upon transfer to fresh growth medium, bacterial cells undergo a lag phase, which varies with the recent growth history of the organisms and the medium into which they have been transferred. Even exponentially growing cells transferred to fresh identical medium require a brief period of adaptation for functions such as carbon dioxide accumulation and pH adjustment.

23. The answer is D. (Chapter 11 I D 1 a) A variety of gram-negative rods are capable of causing urinary tract infection (UTI). *Escherichia coli* is the most commonly isolated etiologic agent of UTI occurring in otherwise healthy individuals. In ambulatory individuals, *E. coli* accounts for about 60 percent of the cases of UTI. *E. coli* also is an important cause of UTI in hospitalized patients; however, other gram-negative rods also assume importance as etiologic agents in this setting.

24. The answer is C. (Chapter 18 II D) Animal viruses are characterized by a particle-to-infectivity ratio of greater than 1. Therefore, any procedure that measures infectivity (e.g., viral plaque assay and direct infectivity assays) underestimates the actual number of viral particles by anywhere from 10 to 10,000. The only way to measure the number of viral particles is to count them in the electron microscope. By combining detection and quantitation techniques it is possible to determine the particle-to-infectivity ratio.

25. The answer is A. (Chapter 21 V F 3) The vaccination for smallpox is a highly effective and very safe procedure. In the years just prior to smallpox eradication, however, the rate of vaccination reactions exceeded the incidence of smallpox. The most common side effect is an eczema resulting from vaccinia virus infection (eczema vaccinatum).

26. The answer is C. (Chapter 4 I A 1 c) Although boiling for extended periods of time and treatment with various chemicals may provide effective disinfection, these methods may not be effective for sterilizing materials. Spores of bacteria and fungi are capable of surviving boiling, chemical treatment, and ultraviolet radiation. Liquids and moist materials that are heat-tolerant or are to be discarded, such as wound dressings, are sterilized most effectively by moist heat of 121° C under 15 lbs of pressure per square inch for 15 to 20 minutes (i.e., autoclaving).

27. The answer is D. (Chapter 27 I A) *Streptococcus pneumoniae* is the most common cause of bacterial pneumonia. In one study, pneumococcal pneumonia accounted for about 25 percent of the cases of pneumonia for which an etiologic agent could be isolated. No definite etiologic agent could be found in two-thirds of the patients in this study, but one-third of these patients had *S. pneumoniae* as indigenous oropharyngeal flora. Pneumococcal pneumonia accounts for approximately 80 percent of all cases of bacterial pneumonia.

28. The answer is E (all). (Chapter 11 I D 1; III B; IV A) The indigenous flora of humans includes many bacteria that are capable of producing disease under the appropriate conditions. *Bacteroides fragilis* and *Escherichia coli* are found in the normal gastrointestinal tract of all individuals. *Bacteroides melaninogenicus* can be isolated from the oropharynx of most individuals, and *Pseudomonas aeruginosa* occurs in the intestinal tract of about 5 percent of healthy individuals.

29. The answer is A (1, 2, 3). (Chapter 13 I A 7) *Treponema pallidum* is highly susceptible to penicillin. Primary and secondary syphilis can be treated effectively with penicillin and other antimicrobial agents. *T. pallidum* can be isolated from the lesions associated with these stages of the disease, and the antimicrobial therapy eradicates the bacteria. Tertiary syphilis is characterized by the absence of the treponeme from the lesions, and this stage of the disease cannot be cured with antimicrobial therapy. Patients with tertiary syphilis can be treated only with supportive therapy. Congenital syphilis also can be treated with penicillin in its early stages. Congenital syphilis can be prevented by treating the infected mother with appropriate antimicrobial agents.

30. The answer is B (1, 3). (Chapter 17 II D, G) Although the lung may be involved in infections caused by the *Phycomycetes* (e.g., *Mucor*, *Rhizopus*, and *Absidia* genera), patients with lung involvement usually have some major underlying disease predisposing them to fungal infection. *Aspergillus* infections of the pulmonary parenchyma also are typically found in immunocompromised individuals. However, in histoplasmosis, blastomycosis, coccidioidomycosis, and paracoccidioidomycosis, pulmonary involvement may be seen in individuals without other apparent problems.

31. The answer is A (1, 2, 3). (Chapter 12 I A 7; II F 2; III C 5) Immunization is a major method of controlling bacterial diseases in humans. Effective vaccines have been prepared against *Haemophilus influenzae*, *Francisella tularensis*, and *Bordetella pertussis*. The *H. influenzae* type b vaccine consists of capsular material and induces high titers of protective antibodies in adults but not in children. A live attenuated vaccine for *F. tularensis* is one of only a few live vaccines available for human use. It generally is administered only to individuals who are at high risk for developing infection. The current vaccine for *B. pertussis* is composed of killed bacteria. There is no vaccine currently available for *Haemophilus ducreyi*.

32. The answer is A (1, 2, 3). (Chapter 3 IV A) Transformation is the exchange of genetic information between bacteria mediated through the transfer of naked DNA. This exchange mechanism has been demonstrated in many bacterial groups and requires that the bacteria be in a well-defined metabolic state, which varies from species to species.

33. The answer is E (all). (Chapter 22 IV E) Rabies is established in virtually every wild mammal population in North America. All of the common domestic animals are susceptible, including cattle. The most common human exposure comes from household pets, but it is not unusual in some parts of the country to have rabid raccoons and skunks enter urban areas.

34. The answer is C (2, 4). (Chapter 9 II B 2, D 3, 4) Some differences exist between strains of *Neisseria gonorrhoeae* that cause urogenital infection and those that cause disseminated disease. Gonococci isolated from patients with disseminated disease usually are highly susceptible to penicillin but are resistant to the natural bactericidal action of serum. These strains also require arginine, uracil, and hypoxanthine for growth. In urogenital disease, the critical step of attachment to urethral epithelium is due to the presence of pili on *N. gonorrhoeae*; strains without pili are unable to cause infection. At the current time, the incidence of gonorrhea caused by β -lactamase- (i.e., penicillinase-) producing *N. gonorrhoeae* still is low.

35. The answer is E (all). (Chapter 27 II A 1) Underlying diseases tend to alter the metabolism or weaken the immunologic defenses of an individual, making the individual more susceptible to viral pneumonia. For a variety of tangible reasons, such as exposure rate, and intangible reasons, such as stress, hospitalization also appears to predispose to viral infection. Any disease or chemotherapeutic agent that affects the cell-mediated immune system predisposes to viral pneumonia; cell-mediated immunity plays a major role in controlling viral infections. The very young and the elderly have a higher incidence of most types of viral pneumonia than the general population, perhaps as the result of the less competent immunity of individuals in these two age groups.

36. The answer is A (1, 2, 3). (Chapter 8 II D 4) Several of the toxic substances produced by *Streptococcus pyogenes* occur in related but chemically or serologically distinct forms. Erythrogenic toxin, more correctly known as streptococcal pyrogenic toxin because of its ability to elicit fever, occurs as three immunologically distinct substances. This toxin is produced by most strains of group A streptococci, and it is thought to play a role in the signs and symptoms of scarlet fever.

37. The answer is C (2, 4). (Chapter 21 V C, D) The eventual eradication of smallpox, a disease that at one time or another affected all parts of the world, was a result of a massive immunization effort in all of the endemic areas. This massive undertaking was possible because a highly effective and easily administered vaccine was available and because the only reservoir for the virus is humans, all of whom develop symptomatic disease.

38. The answer is A (1, 2, 3). (Chapter 18 II B) The presence of viruses in an infected cell culture can be recognized through structural changes that occur during viral infection, such as the cytopathic effect that viruses have on some host cells, through modification of the surface of the cultured cells so that they adsorb red blood cells, and by the presence of viral proteins in the infected cell monolayers. Although there are many measurable changes that occur during virus infection, none have been easily identified as nutritional.

39. The answer is C (2, 4). (Chapter 10 II B 4, 5) Antibodies induced by the administration of tetanus toxoid are of the immunoglobulin G (IgG) class. This class of antibodies are capable of crossing the placental membrane and produce temporary immunity in the fetus and neonate. Active immunization as a result of naturally occurring disease produces no protection in the recovered patient. Tetanus toxoid is prepared by chemical denaturation of active neurotoxin isolated from culture filtrates. Passive immunization (i.e., treatment) is achieved by the administration of tetanus antitoxin (i.e., antibodies against tetanus toxin) that has been produced in an animal host. There is a risk of serum sickness in the patient receiving the antitoxin, and the antibodies are short-lived.

40. The answer is A (1, 2, 3). (Chapter 9 II F 1, 2) The Gram stain and culture of tissue from selected sites are important in the diagnosis of gonorrhea. However, the relevance of these techniques varies depending upon the involved patient. The presence of intracellular gram-negative cocci in pairs in exudate from the male urethra is strong presumptive evidence of gonorrhea. Gram stains of swabbed smears from either the urogenital tract or the anal canal of females is of limited diagnostic value. There are problems involved in swabbing the appropriate area, particularly in the asymptomatic female, and the indigenous flora may be misleading. Gram stain from samples swabbed from the anal canal of homosexual males poses the same problems and also is of very little value. However, cultures of samples from the anal canal of females and homosexual males can be prepared on selective media and are of diagnostic value.

41. The answer is C (2, 4). (Chapter 2 III B) The identification of unknown organisms and the classification of organisms is based on readily observable properties such as the reaction to Gram staining, the presence of a capsule, and fermentation or metabolic activities. The nature of the cell wall of microorganisms is a significant factor in the infectious process of the organism as well as its sensitivity to many antimicrobial drugs.

42. The answer is B (1, 3). (Chapter 5 II B) A lymphoid malignancy implies that there is a neoplastic clone of lymphoid cells. Polyclonal immunoglobulin is heterogeneous and therefore is the product of multiple lymphocyte clones. Likewise the presence of both κ and λ light chains implies that more than one immunoglobulin clones are present. Skin test anergy is often present in lymphoid malignancy. The presence of mature plasma cells in the marrow is suggestive of the histologic picture seen in multiple myeloma.

43. The answer is D (4). (Chapter 13 I A 4, B 1, C 1, D) *Treponema* species are the etiologic agents of yaws, pinta, bejel, and syphilis. Syphilis is the only one of these treponemal diseases that is transmitted from person to person by sexual contact. *Treponema pallidum*, the etiologic agent of syphilis, enters the body through small breaks in the mucous membranes during sexual contact. The disease also can be transmitted by mucous membrane contact and can be passed transplacentally to the fetus.

44. The answer is A (1, 2, 3). (Chapter 30 I A 1) The principal etiologic agents of bacterial meningitis are *Haemophilus influenzae*, *Streptococcus pneumoniae*, and *Neisseria meningitidis*, which account for over 80 percent of cases. Gram-negative enteric rods, such as *Escherichia coli*, account for only a small number of cases.

45-48. The answers are: 45-E, 46-B, 47-E, 48-C. (Chapter 11 IV A 1) Purified exotoxin A from *Pseudomonas aeruginosa* has proved to be lethal for mammalian cells by inhibiting protein synthesis. Studies with a variety of mammalian cells in tissue culture have indicated that the toxin inhibits amino acid uptake by the cells. This inhibition of uptake prevents protein synthesis, which eventually results in death of the cells. The 50 percent lethal dose (LD_{50}) for all experimental animals tested approximates 50 μ g of exotoxin A per kg of body weight.

P. aeruginosa produces several extracellular enzymes that probably serve as virulence factors. At least two proteases are produced, which are elastase and collagenase. Collagenase probably is the most important protease in the destruction of connective tissue in the cornea. *P. aeruginosa* infections of the eye are severe and, if untreated, result in nearly total destruction of the structural tissue of the eye.

Some strains of *P. aeruginosa* produce two pigments. Fluorescein is a blue fluorescent pigment, and pyocyanin is a yellow pigment. Strains that produce both soluble pigments develop a green coloration in the medium surrounding the colonies. These pigments are bactericidal for a variety of other gram-negative rods and at one time were investigated for their potential therapeutic use.

49-52. The answers are 49-B, 50-A, 51-D, 52-D. (Chapter 6 III C 1 a, 2, 3, D) A positive delayed-type hypersensitivity (DTH) skin test for tuberculosis merely indicates exposure to *Mycobacterium tuberculosis*. The test does not necessarily indicate current disease and is of little diagnostic value. The test is used in epidemiologic surveys and in screening individuals for exposure to the pathogen. A positive skin test should be followed by a chest roentgenogram to determine if there is active pulmonary disease. The disease is confirmed by isolation and identification of the etiologic agent.

Cryptococcus neoformans is the only encapsulated yeast of medical importance. The presence of cryptococcal capsular polysaccharide in serum or cerebrospinal fluid (CSF) is indicative of current or very recent disease. A latex bead agglutination test with a high degree of sensitivity to the capsular antigen has been developed. A positive test is considered to be diagnostic.

Species of *Candida* are considered to be indigenous flora of the human oropharynx, intestine, skin, and vagina when they are present in small numbers. Overgrowth of the yeast, particularly of *Candida albicans*, results in mucocutaneous and disseminated candidiasis. Most females and many males dem-