MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) Antoni van Leeuwenhoek was the first person in history to
   A) use the germ theory of disease.
   B) disprove spontaneous generation.
   C) use a magnifying glass.
   D) develop a taxonomic system.
   E) view microorganisms and record these observations.

2) The microbes commonly known as ______ are single-celled eukaryotes that are generally motile.
   A) archaea   B) fungi   C) bacteria   D) protozoa   E) viruses

3) Which of the following statements about algae is FALSE?
   A) They provide most of the oxygen on Earth.
   B) They are a source of food for aquatic and marine animals.
   C) They are important in the degradation of dead plants and animals.
   D) They are photosynthetic organisms.
   E) The group includes seaweeds and kelps.

4) Louis Pasteur demonstrated that fermentation to produce alcohol is caused by
   A) obligate parasites.
   B) aerobes.
   C) facultative anaerobes.
   D) prokaryotes.
   E) archaea.

5) Which of the following scientists provided evidence in favor of the concept of spontaneous generation?
   A) Redi
   B) Pasteur
   C) Spallanzani
   D) Needham
   E) Buchner

6) Pasteur’s experiments on fermentation laid the foundation for
   A) abiogenesis.
   B) epidemiology.
   C) industrial microbiology.
   D) immunology.
   E) antisepsis.

7) Which of the following statements about fungi is FALSE?
   A) Molds are multicellular.
   B) Yeasts are unicellular.
   C) Fungi are eukaryotes.
   D) Fungi are photosynthetic.
   E) Fungi have a cell wall.
8) Which of the following statements concerning Koch's postulates is FALSE?
   A) Koch's postulates cannot be used to demonstrate the cause of all diseases.
   B) All of Koch's postulates must be satisfied before an organism can be shown to cause a particular disease.
   C) A suspected pathogen must be able to be grown in the laboratory.
   D) The suspected pathogen may not be present in all cases of the disease being studied.
   E) Koch's postulates involve the experimental infection of susceptible hosts.

9) Which of the following individuals pioneered the use of chemicals to reduce the incidence of infections during surgery?
   A) Lister
   B) Semmelweis
   C) Snow
   D) Nightingale
   E) Ehrlich

10) The study of the body's defenses against pathogens is called
    A) molecular biology.
    B) epidemiology.
    C) immunology.
    D) etiology.
    E) chemotherapy.

11) Which of the following questions largely stimulated the research of microbes during what is known as the Golden Age of Microbiology?
    A) What causes disease, and is spontaneous generation of microbes possible?
    B) How do genes work?
    C) How should living organisms be classified?
    D) How are microbes related?
    E) How can microorganisms be seen?

12) Parasitic worms, even meters-long tapeworms, are studied in microbiology because
    A) no one else wants to study them.
    B) they are parasites.
    C) diagnosis usually involves microscopic examination of patient samples.
    D) the Gram stain can be used to identify them.
    E) Leeuwenhoek first discovered them.

13) What scientist first hypothesized that gene sequences could provide new insights into evolutionary relationships among all organisms (including microbes)?
    A) Avery
    B) Pauling
    C) Ehrlich
    D) Woese
    E) Kluyver

14) Work by ______ laid the foundations of the field of environmental microbiology.
    A) Koch and Pasteur
    B) Pauling and Woese
    C) Beijerinck and Winogradsky
    D) Lister and Semmelweis
    E) Redi and Spallanzani
15) According to Kluyver and van Niel, which of the following are true of basic biochemical reactions?
   A) Basic biochemical reactions shared by all living things primarily involve transfer of electrons and hydrogen ions.
   B) They primarily involve the transfer of electrons and ions.
   C) There are an unlimited number of them.
   D) They are shared by all living things.
   E) They primarily involve transfers of chemical groups.

16) Semmelweis advocated handwashing as a method of preventing which of the following diseases?
   A) puerperal fever
   B) cholera
   C) syphilis
   D) smallpox
   E) anthrax

17) Paul Ehrlich used chemotherapy to treat
   A) smallpox.
   B) cancer.
   C) cholera.
   D) syphilis.
   E) anthrax.

18) Which of the following is NOT a characteristic of viruses?
   A) They are acellular.
   B) They are composed of genetic material and protein.
   C) They are smaller than prokaryotic cells.
   D) They are visible with a light microscope.
   E) They are obligatory parasites.

19) The first true vaccine protected against disease caused by a(n) _______ pathogen.
   A) viral
   B) protozoal
   C) fungal
   D) archaeal
   E) bacterial

20) All of the following individuals were involved in improving public health in the 19th century EXCEPT
   A) Lister.
   B) Snow.
   C) Nightingale.
   D) Spallanzani.
   E) Semmelweis.

21) Which of the following types of microbe was NOT observed by Leeuwenhoek?
   A) virus
   B) fungus
   C) alga
   D) prokaryote
   E) protozoa

22) Inserting a gene from the hepatitis B virus into yeast so that the yeast produces a viral protein is an example of
   A) etiology.
   B) immunology.
   C) gene therapy.
   D) genetic engineering.
   E) microbial genetics.
23) Which of the following was NOT an aspect of Pasteur’s experiments to disprove spontaneous generation?
   A) The necks of the flasks he used were bent into an S-shape.
   B) The flasks were incubated for very long periods of time.
   C) He boiled the infusions to kill any microbes present.
   D) The flasks were free of microbes until they were opened.
   E) The flasks he used were sealed with corks.

24) Identification of bacteria in the laboratory usually begins with the _______ for placement in one of two large groups of bacteria.
   A) Koch’s stain
   B) Ehrlich magic test
   C) Gram stain
   D) Petri stain
   E) Pasteur fermentation test

25) Which of the following is NOT a characteristic of protozoa?
   A) They frequently possess cilia or flagella.
   B) Most exhibit asexual reproduction.
   C) They are all photosynthetic.
   D) They are eukaryotic organisms.
   E) They are single-celled organisms.

26) Whose search for chemicals that would kill microbes without harming humans was the foundation for chemotherapy?
   A) Lister
   B) Gram
   C) Ehrlich
   D) Koch
   E) Pasteur

27) Which of the following is NOT an observation Pasteur made concerning the fermentation of grape juice?
   A) Some bacteria may produce acid in grape juice.
   B) Yeast can grow in sealed or open flasks of grape juice.
   C) Yeast can grow with or without oxygen.
   D) Yeast cells can grow and reproduce in grape juice.
   E) Pasteurization kills yeast to prevent spoilage of grape juice.

28) What is the correct order for the application of Koch’s postulates?
   I. Inoculate suspect agent into test subject and observe that subject develops disease of interest.
   II. Isolate and culture suspect agent in the laboratory.
   III. Find suspect agent is every case of disease of interest but not in healthy hosts.
   IV. Recover and isolate suspect agent from test subject.

29) John Snow’s research during a cholera outbreak in London laid the foundation for which of the following branches of microbiology?
   A) immunology only
   B) epidemiology only
   C) infection control only
   D) both infection control and epidemiology
   E) infection control, epidemiology, and immunology
30) Robert Koch was involved in research on all of the following topics EXCEPT
   A) the cause of anthrax.
   B) development of a method to determine the cause of an infectious disease.
   C) the cause of tuberculosis.
   D) the cause of fermentation.
   E) techniques for isolating microbes in the laboratory.

31) Which of the following is an INCORRECT pairing?
   A) prokaryotes; no nuclei
   B) fungi; cell walls
   C) viruses; acellular parasites
   D) protozoa; multicellular
   E) algae; aquatic and marine habitats

32) What was the first disease shown to be bacterial in origin?
   A) cholera
   B) tuberculosis
   C) malaria
   D) anthrax
   E) yellow fever

33) The work of Lister, Nightingale, and Semmelweis all contributed to controlling infectious disease by
   A) determining the taxonomic relationships among microbes.
   B) developing methods for reducing nosocomial infections.
   C) identifying the sources of infectious agents.
   D) developing techniques for isolating pathogens.
   E) developing vaccines.

34) Who discovered penicillin?
   A) Kitasato  B) Pasteur  C) Domagk  D) Fleming  E) Ehrlich

35) All of the following were involved in developing the germ theory of disease EXCEPT
   A) Pauling.
   B) Koch.
   C) Fracastoro.
   D) Pasteur.
   E) Snow.

36) Microorganisms characterized by the absence of a nucleus are called
   A) viruses.
   B) fungi.
   C) prokaryotes.
   D) pathogens.
   E) eukaryotes.
37) The term that literally means "against putrefaction" is
   A) chemotherapy.
   B) nosocomial.
   C) recombinant technology.
   D) antisepsis.
   E) prokaryote.

38) The term ________ refers to an infection acquired in a health care setting.
   A) abiogenesis
   B) nosocomial
   C) archaea
   D) bioremediation
   E) spontaneous generation

39) What must one have before designing and conducting experiments?
   A) a theory
   B) a hypothesis
   C) scientific law
   D) a complete set of data
   E) popular opinion

40) Who demonstrated that fermentation could occur in the absence of intact cells?
   A) Buchner
   B) Pasteur
   C) Lister
   D) Woese
   E) Koch

41) The term for the use of microorganisms to restore damaged environments is
   A) epidemiology.
   B) serology.
   C) chemotherapy.
   D) bioremediation.
   E) ecology.

42) The term ________ involves the study of the blood components that fight infection.
   A) bioremediation
   B) antisepsis
   C) chemotherapy
   D) serology
   E) etiology

43) The study of the occurrence, distribution, and spread of disease is known as
   A) serology.
   B) immunology.
   C) epidemiology.
   D) biochemistry.
   E) biotechnology.

TRUE/FALSE. Write 'T' if the statement is true and 'F' if the statement is false.

44) Microbiologists study only single-celled organisms.

45) Christian Gram devised a staining technique that divides all bacteria into two groups.
46) The production of human blood-clotting factor by *E. coli* is an example of bioremediation.

47) Louis Pasteur is considered the Father of Microbiology because of the many carefully conducted experiments and observations he made with microbes.

48) Gene therapy is a modern approach to preventing infectious disease.

49) Koch’s postulates can be used only to determine the causes of infectious diseases.

50) Joseph Lister reduced the incidence of wound infections in health care settings by using chlorinated lime water.

51) Robert Koch developed a vaccine to prevent anthrax after identifying the causative agent.

52) Fermentation can occur in the absence of living cells.

53) Lazzaro Spallanzani was the first scientist to provide evidence disproving the spontaneous generation of microorganisms.

**SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.**

54) The amateur scientist (Koch/Leeuwenhoek/Pasteur) made his own microscopes and first reported the existence of microbes.

55) A cell that contains a nucleus is called a(n) (prokaryotic/archaeal/eukaryotic) cell.

56) A(n) (photosynthetic/algae/plant) organism makes its own food using light energy.

57) Microbes that cause infectious disease are called (pathogens/germs/viruses).

58) The desire to prevent (infection/disease/sepsis), literally "putrefaction," resulted in many developments leading to modern medicine.

59) A scientist conducts experiments to test a(n) (observation/hypothesis/theory).

60) The development of molecular biology has made possible the application of (genome sequencing/gene sequences/gene sequencing) to provide a better understanding of the relationships between organisms.

61) Research done in Robert Koch’s laboratory laid the foundation for (epidemiology/immunology/etiology), the study of the body’s defenses against disease.

62) A (colony/habitat/biofilm) is a community of microbes growing on surfaces.

63) Spallanzani’s experiments contradicted the experiments of (Needham/Redi/Pasteur) on spontaneous generation.
64) Ignaz Semmelweis demonstrated the importance of (antisepsis/vaccination/washing) as a means of preventing disease transmission.

65) A term synonymous with immunization, (vaccination/infection) is derived from the Latin name of the cowpox virus.

66) The use of chemicals to treat diseases such as bacterial infections is called (gene therapy/chemotherapy).

67) Organisms such as bacteria that can convert atmospheric nitrogen into nitrate are often studied in (environmental/bioremediation/ecologic) microbiology.

68) The (physiology/metabolism) of an organism is all the chemical reactions that take place in the organism.

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

69) You are a young scientist who has just learned about one of the hot topics in microbiology, biofilms. One aspect of the interest in biofilms is that the microbes living within biofilms appear to behave and function differently from their counterparts not living in a biofilm. Devise a way to explore the idea. (Do not focus on the technical details of how this might be accomplished.)

70) Biotechnology can be said to have ancient roots. Explain.

71) Use the basic steps of the scientific method to describe Pasteur's experiments to investigate spontaneous generation.

72) Explain how the discipline of biochemistry grew out of the science of microbiology.

73) Compare and contrast the three types of eukaryotic microbes.
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51) FALSE
52) TRUE
53) TRUE
54) Leeuwenhoek
55) eukaryotic
56) photosynthetic
57) pathogens
58) sepsis
59) hypothesis
60) gene sequencing
61) immunology
62) biofilm
63) Needham
64) washing
65) vaccination
66) chemotherapy
67) environmental
68) metabolism

69) Many answers are possible. A good answer should have a clear statement of hypothesis and an experimental design that reflects the hypothesis and will provide interpretable quantitative results. An excellent answer may include projections of possible outcomes and/or alternative hypotheses.

70) Biotechnology is the use of microbes to yield beneficial products. Humans have used microbes to their benefit for millennia in producing beer and wine, which were often safer to drink than the available water, and in preserving foods. Examples of the latter include the production of wine, which essentially preserved fruit juices, and of cheese and yogurt, which extended the storage life of milk products. Soy sauce and other fermented sauces were also preserved by fermentation and were later shown to enhance the flavors of certain foods.

71) The observation that life seemed to appear from non-life led some scientists to believe in the theory of spontaneous generation. However, Pasteur among others believed in biogenesis: that life must come from life. The question Pasteur hoped to answer was "Where do microbes come from?" (step 1). Pasteur's hypothesis (step 2) was that the "parents" of microbes were present in the air on dust particles. In his experiments (step 3) he used swan-necked flasks, which were designed to prevent microbes from entering the sterile broth inside them. He observed that the broth remained sterile in the control flask even though air could move into and out of the flask. The experimental flasks were also swan-necked, but they were tilted to allow the dust that had settled to enter the flask. The control flasks stayed sterile, and the experimental flasks became cloudy. These observations led Pasteur to accept his hypothesis (step 4). He concluded that the microbes came from the dust and that spontaneous generation was therefore not a valid theory.

72) Some of the first experiments in biochemistry are attributed to Louis Pasteur in his research on the causes of fermentation. His research was extended by Eduard Buchner, who showed that enzymes produced by microbial cells are responsible for the phenomenon of fermentation. Later, in the early 20th century, Kluyver and van Niel advocated the use of microbes in research on basic biochemical reactions, which they maintained are common to all living things. Further advances in biochemistry were made as microbiologists such as Beadle and Tatum and Avery and his colleagues explored the nature of the genetic material and its function using microorganisms as model systems.

73) The three types of eukaryotic microbes are fungi, protozoa, and algae. Because they are all composed of eukaryotic cells, they have basic similarities in cellular structure, including the presence of a nucleus. However, these types of microbes differ in many ways as well. In terms of their nutrition, fungi and protozoa obtain their food from other organisms, whereas algae can make their own food through photosynthesis (a few protozoa also carry out photosynthesis). Algae and fungi can be multicellular organisms, but protozoa are found only as single-celled organisms. Protozoa are unique among the three in that they are animal-like in their characteristics, including movement. Algae are most like plants and are found in primarily water-based environments.