

**Registration form**

**PATHOGENS 101**  
**48 HOUR RUSH ORDER PROCESSING FEE ADDITIONAL \$50.00**

**Start and Finish Dates:** \_\_\_\_\_  
*You will have 90 days from this date in order to complete this course*

List number of hours worked on assignment must match State Requirement. \_\_\_\_\_

**Name** \_\_\_\_\_ **Signature** \_\_\_\_\_  
*I have read and understood the disclaimer notice on page 2. Digitally sign XXX*

**Address** \_\_\_\_\_

**City** \_\_\_\_\_ **State** \_\_\_\_\_ **Zip** \_\_\_\_\_

**Email** \_\_\_\_\_ **Fax (\_\_\_\_)** \_\_\_\_\_

**Phone:**  
**Home (\_\_\_\_)** \_\_\_\_\_ **Work (\_\_\_\_)** \_\_\_\_\_

**Operator ID #** \_\_\_\_\_ **Exp. Date** \_\_\_\_\_

**Class/Grade** \_\_\_\_\_

**Please circle/check which certification you are applying the course CEU's.**  
Water Treatment \_\_\_ Water Distribution \_\_\_ Other \_\_\_\_\_

**Technical Learning College TLC PO Box 3060, Chino Valley, AZ 86323**  
**Toll Free (866) 557-1746 Fax (928) 272-0747 [info@tlch2o.com](mailto:info@tlch2o.com)**

**If you've paid on the Internet, please write your Customer#** \_\_\_\_\_

**Please invoice me, my PO#** \_\_\_\_\_

**Please pay with your credit card on our website under Bookstore or Buy Now. Or call us and provide your credit card information.**

***We will stop mailing the certificate of completion so we need either your fax number or e-mail address. We will e-mail the certificate to you, if no e-mail address; we will fax it to you.***

## **DISCLAIMER NOTICE**

I understand that it is my responsibility to ensure that this CEU course is either approved or accepted in my State for CEU credit. I understand State laws and rules change on a frequent basis and I believe this course is currently accepted in my State for CEU or contact hour credit, if it is not, I will not hold Technical Learning College responsible. I also understand that this type of study program deals with dangerous conditions and that I will not hold Technical Learning College, Technical Learning Consultants, Inc. (TLC) liable for any errors or omissions or advice contained in this CEU education training course or for any violation or injury or neglect or damage caused by this CEU education training or course material suggestion or error. I will call or contact TLC if I need help or assistance and double-check to ensure my registration page and assignment has been received and graded.

**State Approval Listing Link**, check to see if your State accepts or has pre-approved this course. Not all States are listed. Not all courses are listed. If the course is not accepted for CEU credit, we will give you the course free if you ask your State to accept it for credit.

**Professional Engineers**; Most states will accept our courses for credit but we do not officially list the States or Agencies. Please check your State for approval.

## **State Approval Listing URL...**

<http://www.abctlc.com/downloads/PDF/CEU%20State%20Approvals.pdf>

*You can obtain a printed version of the course manual from TLC for an additional \$169.95 plus shipping charges.*

## **AFFIDAVIT OF EXAM COMPLETION**

I affirm that I personally completed the entire text of the course. I also affirm that I completed the exam without assistance from any outside source. I understand that it is my responsibility to file or maintain my certificate of completion as required by the state or by the designation organization.

## **Grading Information**

In order to maintain the integrity of our courses we do not distribute test scores, percentages or questions missed. Our exams are based upon pass/fail criteria with the benchmark for successful completion set at 70%. Once you pass the exam, your record will reflect a successful completion and a certificate will be issued to you.

## **Rush Grading Service**

If you need this assignment graded and the results mailed to you within a 48-hour period, prepare to pay an additional rush service handling fee of \$50.00. This fee may not cover postage costs. If you need this service, simply write RUSH on the top of your Registration Form. We will place you in the front of the grading and processing line.

For security purposes, please fax or e-mail a copy of your driver's license and always call us to confirm we've received your assignment and to confirm your identity.

## CERTIFICATION OF COURSE PROCTOR

Technical Learning College requires that our students who takes a correspondence or home study program course must pass a proctored course reading, quiz and final examination. The proctor must complete and provide to the school a certification form approved by the commission for each examination administered by the proctor.

**Instructions.** When a student completes the course work, fill out the blanks in this section and provide the form to the proctor with the examination.

Name of Course: \_\_\_\_\_

Name of Licensee: \_\_\_\_\_

**Instructions to Proctor.** After an examination is administered, complete and return this certification and examination to the school in a sealed exam packet or in pdf format.

I certify that:

1. I am a disinterested third party in the administration of this examination. I am not related by blood, marriage or any other relationship to the licensee which would influence me from properly administering the examination.
2. The licensee showed me positive photo identification prior to completing the examination.
3. The enclosed examination was administered under my supervision on \_\_\_\_\_. The licensee received no assistance and had no access to books, notes or reference material.
4. I have not permitted the examination to be compromised, copied, or recorded in any way or by any method.
5. Provide an estimate of the amount of time the student took to complete the assignment.

Time to complete the entire course and final exam. \_\_\_\_\_

Notation of any problem or concerns:

Name and Telephone of Proctor (please print):

\_\_\_\_\_

\_\_\_\_\_

Signature of Proctor



# Pathogens 101 Answer Key

Name \_\_\_\_\_

Phone \_\_\_\_\_

Did you check with your State agency to ensure this course is accepted for credit?

**No refunds.**

You are responsible to ensure this course is accepted for credit. No refunds.

Method of Course acceptance confirmation. Please fill this section

Website \_\_\_ Telephone Call \_\_\_ Email \_\_\_ Spoke to \_\_\_\_\_

Did you receive the approval number, if applicable? \_\_\_\_\_

What is the course approval number, if applicable? \_\_\_\_\_

***You can electronically complete this assignment in Adobe Acrobat DC.***

Please Circle, Bold, Underline or X, one answer per question. A **felt tipped pen** works best.

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*I understand that I am 100 percent responsible to ensure that TLC receives the Assignment and Registration Key and that it is accepted for credit by my State or Providence. I understand that TLC has a zero tolerance towards not following their rules, cheating or hostility towards staff or instructors. I need to complete the entire assignment for credit. There is no credit for partial assignment completion. My exam was proctored. I will contact TLC if I do not hear back from them within 2 days of assignment submission. I will forfeit my purchase costs and will not receive credit or a refund if I do not abide with TLC's rules. I will not hold TLC liable for any errors, injury, death or non-compliance with rules. I will abide with all federal and state rules and rules found on page 2.*

**Please Sign that you understand and will abide with TLC's Rules.**

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**Signature**

***Please write down any questions you were not able to find the answers or that have errors.***

## **When Finished with Your Assignment...**

### **REQUIRED DOCUMENTS**

Please scan the **Registration Page, Answer Key, Proctoring report, Survey and Driver's License** and email these documents to [info@TLCH2O.com](mailto:info@TLCH2O.com).

### **IPhone Scanning Instructions**

If you are unable to scan, take a photo of these documents with your **iPhone** and send these photos to TLC, [info@TLCH2O.com](mailto:info@TLCH2O.com).

### **FAX**

If you are unable to scan and email, please fax these documents to TLC, if you fax, call to confirm that we received your paperwork. **(928) 468-0675**

### **Rush Grading Service**

If you need this assignment graded and the results mailed to you within a 48-hour period, prepare to pay an additional rush service handling fee of \$50.00.

*This course contains general EPA's SDWA federal rule requirements. Please be aware that each state implements water / sampling procedures/ safety / environmental / SDWA regulations that may be more stringent than EPA's regulations. Check with your state environmental/health agency for more information. These rules change frequently and are often difficult to interpret and follow. Be careful to be in compliance with your regulatory agencies and do not follow this course for any compliance concerns.*

**Please e-mail or fax this survey along with your final exam**

**PATHOGENS 101 CEU COURSE  
CUSTOMER SERVICE RESPONSE CARD**

NAME: \_\_\_\_\_

E-MAIL \_\_\_\_\_ PHONE \_\_\_\_\_

**PLEASE COMPLETE THIS FORM BY CIRCLING THE NUMBER OF THE APPROPRIATE ANSWER IN THE AREA BELOW.**

Please rate the difficulty of your course.

Very Easy    0    1    2    3    4    5    Very Difficult

Please rate the difficulty of the testing process.

Very Easy    0    1    2    3    4    5    Very Difficult

Please rate the subject matter on the exam to your actual field or work.

Very Similar    0    1    2    3    4    5    Very Different

How did you hear about this Course? \_\_\_\_\_

What would you do to improve the Course?

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Any other concerns or comments.

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## Pathogens 101 CEU Training Course Assignment

The Pathogens 101 CEU course assignment is available in Word on the Internet for your convenience, please visit [www.ABCTLc.com](http://www.ABCTLc.com) and download the assignment and e-mail it back to TLC.

You will have 90 days from receipt of this manual to complete it in order to receive your Professional Development Hours (PDHs) or Continuing Education Unit (CEU). A score of 70 % or better is necessary to pass this course. If you should need any assistance, please email all concerns and the completed ANSWER KEY to [info@tlch2o.com](mailto:info@tlch2o.com).

Select one answer per question. Please utilize the answer key. (s) on the answer will indicate either plural and singular tenses.

### Hyperlink to the Glossary and Appendix

<http://www.abctlc.com/downloads/PDF/WTGlossary.pdf>

### Three Types of Public Water Systems

1. Provides water to the same population year-round for example: homes, apartment buildings.  
A. TNCWS    C. NTNCWSs  
B. CWSs    D. None of the above
2. Approximately 85,000 systems.  
A. TNCWS    C. NTNCWSs  
B. CWSs    D. None of the above
3. Approximately 52,000 systems serving the majority of the U.S. population  
A. TNCWS    C. NTNCWSs  
B. CWSs    D. None of the above
4. Provides water to the same people at least six months a year, but not all year for example: schools, factories, churches, office buildings that have their own water system)  
A. TNCWS    C. NTNCWSs  
B. CWSs    D. None of the above
5. Approximately 18,000 water systems  
A. TNCWS    C. NTNCWSs  
B. CWSs    D. None of the above
6. Provides water where people do not remain for long periods for example: gas stations, campgrounds.  
A. TNCWS    C. NTNCWSs  
B. CWSs    D. None of the above

### Water Quality Section

#### Surface (Raw) Water Introduction

7. \_\_\_\_\_ enhancement and formation of policy measures (administrative and engineering) revolves around most effective types of treatment methods and/or chemicals.  
A. Universal solvent    C. Surface water  
B. Water quality    D. None of the above

8. Raw water generally contains varying amounts of dissolved minerals including calcium, magnesium, sodium, chlorides, sulfates and bicarbonates, depending on its source.

- A. True      B. False

9. Operators need to appropriately treat surface water is never pure of \_\_\_\_\_, it. Most of the earth's water sources obtain their water supplies through precipitation.

- A. Excess nutrients      C. Pollution  
B. Biological actions      D. None of the above

10. Water passes runoffs and infiltrates the ground during precipitation; this runoff acquires a wide variety of \_\_\_\_\_ that intensely alters its usefulness.

- A. Excess nutrients      C. Dissolved or suspended impurities  
B. Biological actions      D. None of the above

### Surface Water Properties

11. Runoff could produce mud, leaves, decayed vegetation, and human and animal refuse. The discharge from industry could increase \_\_\_\_\_. Some lakes and reservoirs may experience seasonal turnover.

- A. Volatile organic compounds      C. Excess nutrients  
B. Water quality      D. None of the above

12. Adjustments in the dissolved oxygen, algae, temperature, suspended solids, turbidity, and carbon dioxide will change because of \_\_\_\_\_.

- A. Excess nutrients      C. Discharge  
B. Biological actions      D. None of the above

13. Water is accepted as the \_\_\_\_\_ because will dissolve most substances that comes in contact.

- A. Universal solvent      C. Surface water  
B. Water quality      D. None of the above

14. Depending on the region, some lakes and rivers receive \_\_\_\_\_ from sewer facilities or defective septic tanks.

- A. Excess nutrients      C. Discharge  
B. Biological actions      D. None of the above

### Managing Water Quality at the Source

15. Contingent upon the region, source water may have several restrictions of use as part of a Water Shed Management Plan. In some areas, it may be restricted from recreational use, discharge or runoff from agriculture, or \_\_\_\_\_.

- A. Excess nutrients      C. Industrial and wastewater discharge  
B. Biological actions      D. None of the above

16. Another characteristic of quality control is aquatic plants. The ecological equilibrium in lakes and reservoirs plays a natural part in purifying and sustaining the life of the lake. Certain vegetation removes the excess nutrients that would promote the growth of algae. Too much algae will imbalance the lake and kill fish.

- A. True      B. False

17. Algae growth is supplied by the energy of the sun. As algae absorbs this energy, it converts carbon dioxide to oxygen. Algae and rooted aquatic plants are essential in the food chain of fish and birds. Algae growth is the result of photosynthesis.

- A. True      B. False

18. The absence of dissolved oxygen in water is known as aerobic conditions.

- A. True      B. False

19. Most treatment plant upsets are such as taste and odor, color, and filter clogging is due to algae. The type of algae determines the problem it will cause, for instance slime, corrosion, color, and toxicity.

- A. True      B. False

20. Algae can be controlled in the water supply by using chemicals such as \_\_\_\_\_.

- A. pH and alkalinity      C. Powdered activated carbon and chlorine  
B. Copper sulfate      D. None of the above

21. Contingent upon federal regulations and the amount of copper found natural in water, operators have used \_\_\_\_\_, powdered activated carbon and chlorine to control algae blooms.

- A. pH and alkalinity      C. Potassium permanganate  
B. Metals, and non-metals      D. None of the above

22. The \_\_\_\_\_ of the water will govern how these chemicals will react.

- A. pH and alkalinity      C. Powdered activated carbon and chlorine  
B. Metals, and non-metals      D. None of the above

### Physical Characteristics of Water

23. Physical characteristics are the elements found that are considered alkali, metals, and non-metals such as carbonates, fluoride, \_\_\_\_\_. The consumer relates it to scaling of faucets or staining.

- A. pH and alkalinity      C. Powdered activated carbon and chlorine  
B. Sulfides or acids      D. None of the above

24. Total Dissolved Solids (TDS) is not a primary pollutant; it is a gauge of appealing water characteristics such as hardness and an indication of an assortment of chemical contaminants that might be present, such as?

- A. Turbidity      C. Arsenic  
B. Colloids      D. None of the above

25. pH is the negative logarithm of the hydrogen ion concentration,  $[H^+]$ , a measure of the degree to which a solution is \_\_\_\_\_.

- A. Alkalinity      C. Hydrogen ion ( $H^+$ )  
B. Acidic or alkaline      D. None of the above

26. \_\_\_\_\_ is a substance that can give up a hydrogen ion ( $H^+$ ); a base is a substance that can accept  $H^+$ .

- A. Acid      C. Acidic or alkaline  
B. Base      D. None of the above

27. The more acidic a solution the greater the hydrogen ion concentration and the lower the pH; a pH of 7.0 indicates neutrality, a pH of less than 7 indicates acidity, and a pH of more than 7 indicates \_\_\_\_\_.

- A. Acid      C. Alkalinity  
B. Base      D. None of the above

### Alkalinity

28. Alkalinity of water is its acid-neutralizing capacity. It is the sum of all the titratable bases. The measured value may vary significantly with the end-point pH used.

- A. True      B. False

29. Alkalinity is a measure of \_\_\_\_\_ and can be interpreted in terms of specific substances only when the chemical composition of the sample is known.
- A. Hydrogen ion ( $H^+$ )            C. An aggregate property of water  
B. Alkaline earth metal            D. None of the above
30. Alkalinity is substantial in many uses and treatments of natural waters and wastewaters. Because the alkalinity of many surface waters is primarily a function of carbonate, bicarbonate, and hydroxide content, it is taken as an indication of the concentration of these constituents. The measured values also may include contributions from borates, phosphates, silicates or other bases if these are present.
- A. True            B. False
31. \_\_\_\_\_ with an overabundance of alkaline earth metal concentrations is significant in determining the suitability of water for irrigation.
- A. Alkalinity            C. Hydrogen ion ( $H^+$ )  
B. Acid            D. None of the above
32. Alkalinity measurements are used in the interpretation and control of water and wastewater treatment processes
- A. True            B. False

### **Turbidity Introduction**

33. High levels of turbidity may inhibit with proper water treatment and monitoring. If high quality raw water is low in turbidity, there will be a reduction in water treatment costs. Turbidity is unwanted because it causes health hazards.
- A. True            B. False
34. The turbidity in natural surface waters is composed of a large number of sizes of particles. The sizes of particles can be changing constantly, depending on precipitation and \_\_\_\_\_ factors.
- A. MCL            C. Temperature  
B. Manmade            D. None of the above
35. When heavy rains transpire, runoff into streams, rivers, and reservoirs occurs, causing turbidity levels to increase. In most cases, the particle sizes are relatively large and settle relatively quickly in both the water treatment plant and the source of supply. However, in some instances, fine, colloidal material may be present in the supply, which may cause some difficulty in the coagulation process.
- A. True            B. False
36. One physical feature of water is turbidity. A measure of the cloudiness of water caused by \_\_\_\_\_. The cloudy appearance of water caused by the presence of tiny particles.
- A. Suspended particles            C. Temperature fluctuation  
B. Variations            D. None of the above
37. Generally, higher turbidity levels require higher coagulant dosages. However, seldom is the relationship between turbidity level and \_\_\_\_\_ linear.
- A. Coagulant dosage            C. Temperature  
B. Total Dissolved Solids (TDS)            D. None of the above
38. Usually, the extra coagulant required is relatively small when turbidities are much higher than normal due to higher collision probabilities of the \_\_\_\_\_ during high turbidities.
- A. Turbidity            C. Total Dissolved Solids (TDS)  
B. Colloids            D. None of the above



39. Low \_\_\_\_\_ waters can be very difficult to coagulate due to the difficulty in inducing collision between the colloids.

- A. Turbidity
- B. Colloids
- C. Total Dissolved Solids (TDS)
- D. None of the above

40. \_\_\_\_\_ may be existing in a water supply due to pollution, and these colloids can be difficult to remove in the coagulation process. In this situation, higher coagulant dosages are generally required.

- A. Turbidity
- B. Organic colloids
- C. Total Dissolved Solids (TDS)
- D. None of the above

### **Turbidity MCL**

41. The temperature variation of a sample, a scratched or unclean sample tube in the nephelometer and selecting an incorrect wavelength of a light path may be conditions caused by an inaccurate \_\_\_\_\_ measurement.

- A. Conductivity
- B. Turbidity
- C. Temperature
- D. None of the above

42. An MCL for turbidity established by the EPA because \_\_\_\_\_ interferes with disinfection. This characteristic of water changes the most rapidly after a heavy rainfall.

- A. Conductivity
- B. Turbidity
- C. Temperature
- D. None of the above

### **Dissolved Oxygen**

43. The level of dissolved oxygen in natural waters is often a direct indication of quality, since aquatic plants produce oxygen, while microorganisms generally consume it as they feed on \_\_\_\_\_.

- A. Pollutants
- B. Organic matter
- C. E. coli bacteria
- D. None of the above

44. \_\_\_\_\_ is essential for the support of fish and other aquatic life and aids in the natural decomposition of organic matter.

- A. Dissolved oxygen
- B. Thermal stratification
- C. Solubility of oxygen
- D. None of the above

45. Thermal stratification is possible as water becomes less dense when heated, meaning water weighs less per unit volume. Therefore, warmer water will be lighter and colder water will be heavier. Due to this, there will always be a level of "self-induced" \_\_\_\_\_ in a water storage.

- A. Saturation level(s)
- B. Thermal stratification
- C. Permanent hardness
- D. None of the above

46. At low temperatures, the \_\_\_\_\_ is increased, so that in winter, concentrations as high as 20 ppm may be found in natural waters; during summer, saturation levels can be as low as 4 or 5 ppm.

- A. Dissolved oxygen
- B. Thermal stratification
- C. Solubility of oxygen
- D. None of the above

### **Secondary Standard**

47. TDS is most often measured in parts per million (ppm) or milligrams per liter of water (mg/L). The normal TDS level ranges from \_\_\_\_\_

- A. 50 ppm to 1,000 ppm
- B. 5 ppm to 10 ppm
- C. 50 ppm to 100 ppm
- D. None of the above

48. The Environmental Protection Agency (EPA), which is responsible for drinking water regulations in the United States, has identified TDS as a secondary standard, meaning that it is a voluntary guideline. While the United States set legal standards for many harmful substances, TDS, along with other contaminants that cause aesthetic, cosmetic, and technical effects, has only a guideline.

- A. True      B. False

### Langelier Saturation Index

49. The Langelier Saturation index (LSI) is an evenness scale derived from the theoretical concept of saturation and provides an indicator of the degree of saturation of water with respect to calcium carbonate. It can be shown that the Langelier saturation index (LSI) approximates the base 10 logarithm of the \_\_\_\_\_ saturation level.

- A. Magnesium carbonate      C. Calcite  
B. Calcium carbonate      D. None of the above

50. The Langelier saturation level approaches the concept of saturation using pH as a main variable. The LSI can be interpreted as the pH change required to bring water to \_\_\_\_\_.

- A. Saturation level(s)      C. Equilibrium  
B. Stratification      D. None of the above

### More on the Stage 2 DBP Rule

51. There are specific microbial pathogens, such as \_\_\_\_\_, which can cause illness, and are highly resistant to traditional disinfection practices.

- A. Cryptosporidium      C. Protozoa  
B. E. coli host culture      D. None of the above

52. The Stage 1 Disinfectants and Disinfection Byproducts Rule and \_\_\_\_\_, promulgated in December 1998.

- A. Stage 1 DBPR      C. Interim Enhanced Surface Water Treatment Rule  
B. Stage 2 DBPR      D. None of the above

53. Which of the following rules will reduce potential cancer and reproductive and developmental health risks from disinfection byproducts?

- A. Stage 1 DBPR      C. Long Term 2 Enhanced Surface Water Rule  
B. Stage 2 DBPR      D. None of the above

54. Which of the following rules focuses on public health protection by limiting exposure to DBPs, specifically total trihalomethanes and five haloacetic acids, which can form in water through disinfectants used to control microbial pathogens?

- A. Stage 2 DBP rule      C. Long Term 2 Enhanced Surface Water Treatment Rule  
B. Stage 1 DBPR      D. None of the above

55. Safe Drinking Water Act (SDWA) has been highly effective in protecting public health and has evolved to respond to new and emerging threats to safe drinking water.

- A. True      B. False

56. Which of the following is one of the major public health advances in the 20th century?

- A. Disinfection of drinking water      C. Amendments to the SDWA  
B. Water distribution      D. None of the above

### What are Disinfection Byproducts (DBPs)?

57. Which of the following form when disinfectants used to treat drinking water react with naturally occurring materials in the water?

- A. Chloramines      C. Disinfection byproducts (DBPs)  
B. Humic and fulvic acids      D. None of the above

58. Total trihalomethanes and haloacetic acids are widely occurring \_\_\_\_\_ formed during disinfection with chlorine and chloramine.

- A. Gases
- B. Substances
- C. Classes of DBPs
- D. None of the above

**Are THMs and HAAs the only disinfection byproducts?**

59. The presence of TTHM and HAA5 is representative of the occurrence of many other chlorination DBPs; thus, an increase of TTHM and HAA5 generally indicates an increase of DBPs from chlorination.

- A. True
- B. False

**All disinfectants form DBPs in one of two reactions:**

60. Chlorine and chlorine-based compounds (halogens) react with organics in water causing the hydrogen atom to substitute other atoms, resulting in halogenated by-products.

- A. True
- B. False

61. Secondary by-products are also formed when multiple disinfectants are used.

- A. True
- B. False

62. The EPA Surface Water Treatment Rule (SWTR) requires systems using public water supplies from either surface water or groundwater under the direct influence of surface water to disinfect.

- A. True
- B. False

**Public Health Concerns**

63. Results from toxicology studies have shown several DBPs (e.g., bromodichloromethane, bromoform, chloroform, dichloroacetic acid, and bromate) to be inert to laboratory animals.

- A. True
- B. False

64. Other DBPs (e.g., chlorite, bromodichloromethane, and certain haloacetic acids) have also been shown to cause adverse mutations (extra chromosomes) in laboratory animals.

- A. True
- B. False

**Disinfection Byproduct Research and Regulations Summary**

65. \_\_\_\_\_ is unquestionably the most important step in the treatment of water for drinking water supplies.

- A. DBP(s)
- B. Turbidity (particle)
- C. Disinfection
- D. None of the above

66. The \_\_\_\_\_ should not be compromised because of concern over the potential long-term effects of disinfectants and DBPs.

- A. DBP(s)
- B. Turbidity (particle)
- C. Microbial quality of drinking water
- D. None of the above

67. The risk of illness and death resulting from exposure to pathogens in drinking water is very much greater than the risks from \_\_\_\_\_.

- A. Disinfectants and DBPs
- B. Turbidity (particle)
- C. Natural organic matter precursors
- D. None of the above

**Controlling Disinfection Byproducts**

68. Treatment techniques are available that provide water suppliers the opportunity to maximize potable water safety and quality while minimizing the risk of \_\_\_\_\_.

- A. DBP risks
- B. Turbidity (particle)
- C. Disinfectants and DBPs
- D. None of the above

69. Generally, the best approach to reduce \_\_\_\_\_ is to remove natural organic matter precursors prior to disinfection.

- A. DBP(s)
- B. Turbidity (particle)
- C. DBP formation
- D. None of the above

**The EPA guidance discusses three processes to effectively remove natural organic matter prior to disinfection:**

**Coagulation and Clarification**

70. Most treatment plants optimize their coagulation process for \_\_\_\_\_ removal.

- A. Inorganic coagulants
- B. Most contaminants
- C. Turbidity (particle)
- D. None of the above

71. Coagulation processes can also be optimized for natural organic matter removal with higher doses of \_\_\_\_\_ (such as alum or iron salts), and optimization of pH.

- A. THMs and HAAs
- B. Inorganic coagulants
- C. Natural organic matter
- D. None of the above

**Absorption**

72. Activated carbon can be used to absorb \_\_\_\_\_ that react with disinfectants to form byproducts.

- A. Inorganic coagulants
- B. Most contaminants
- C. Soluble organics
- D. None of the above

**Membrane Technology**

73. EPA predicted that most water systems will be able to achieve compliance with new DBP regulations through the use of one or more of these relatively low cost methods (EPA, 1998). Water system managers may also consider switching from chlorine to alternative disinfectants to reduce formation of \_\_\_\_\_.

- A. THMs and HAAs
- B. Optimization of pH
- C. Natural organic matter
- D. None of the above

74. Membranes, used historically to desalinate brackish waters, have also demonstrated excellent removal of \_\_\_\_\_.

- A. THMs and HAAs
- B. Optimization of pH
- C. Natural organic matter
- D. None of the above

75. Membrane processes use hydraulic pressure to force water through a semi-permeable membrane that rejects most \_\_\_\_\_. Variations of this technology include reverse osmosis (RO), nanofiltration (low pressure RO), and microfiltration (comparable to conventional sand filtration).

- A. Inorganic coagulants
- B. Contaminants
- C. Insoluble organics
- D. None of the above

76. Other conventional methods of reducing DBP formation include changing the point of chlorination and using \_\_\_\_\_ for residual disinfection.

- A. Free residual disinfection
- B. Chloramines
- C. Total residual disinfection
- D. None of the above

**Bacteriological Monitoring Section**

**Organisms Descriptors and Meanings**

77. Facultative means...

- A. Without air
- B. With air or without air
- C. Self (Inorganic carbon)
- D. None of the above

78. Aerobic means...  
 A. Without air            C. Self (Inorganic carbon)  
 B. With air                D. None of the above
79. Photo means...  
 A. Feed or nourish            C. Light  
 B. Other (Organic carbon)    D. None of the above
80. Troph means...  
 A. Feed or nourish            C. Light  
 B. Other (Organic carbon)    D. None of the above
81. Litho means...  
 A. Rock            C. Light  
 B. Organic        D. None of the above
82. Organo means...  
 A. Rock            C. Light  
 B. Organic        D. None of the above
83. Auto means...  
 A. Without air            C. Self (Inorganic carbon)  
 B. With air                D. None of the above
84. Chemo means...  
 A. Rock            C. Chemical  
 B. Organic        D. None of the above
85. Hetero means...  
 A. Feed or nourish            C. Light  
 B. Other (Organic carbon)    D. None of the above
86. Anaerobic means...  
 A. Without air            C. Self (Inorganic carbon)  
 B. With air                D. None of the above

**Contaminants that may be present in sources of drinking water include:**

87. Which of the following like salts and metals, which can be naturally occurring or result from urban stormwater runoff, industrial or domestic wastewater discharges, oil and gas production, mining or farming?  
 A. Radioactive contaminants            C. Inorganic contaminants  
 B. Pesticides and herbicides            D. Microbial contaminants
88. Which of the following may come from a variety of sources such as agriculture, urban stormwater run-off, and residential uses?  
 A. Radioactive contaminants            C. Inorganic contaminants  
 B. Pesticides and herbicides            D. Microbial contaminants
89. Which of the following, such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations and wildlife?  
 A. Microbial contaminants            C. Inorganic contaminants  
 B. Pesticides and herbicides            D. None of the above

90. Which of the following can be synthetic and volatile organic chemicals, which are by-products of industrial processes and petroleum production, and can come from gas stations, urban stormwater runoff, and septic systems?

- A. Organic chemical contaminants
- B. Pesticides and herbicides
- C. Inorganic contaminants
- D. Microbial contaminants

91. Which of the following can be naturally occurring or be the result of oil and gas production and mining activities?

- A. Radioactive contaminants
- B. Pesticides and herbicides
- C. Inorganic contaminants
- D. Microbial contaminants

### **Background**

92. Coliform bacteria and chlorine residual are the only routine sampling and monitoring requirements for small ground water systems with chlorination. The coliform bacteriological sampling is governed by the Coliform Reduction amendment of the SDWA.

- A. True
- B. False

### **TCR**

93. The TCR recommends most of the Public Water Systems (PWS) to monitor their distribution system for bacteria according to the written sample sitting plan for that system.

- A. True
- B. False

94. The sample sitting plan identifies sampling frequency and locations throughout the distribution system that are selected to be representative of conditions in the entire system.

- A. True
- B. False

95. Coliform contamination may occur anywhere in the system, possibly due to problems such as; high pressure conditions, line fluctuations, or wells, and therefore routine monitoring is required.

- A. True
- B. False

### **Routine Sampling Requirements**

96. If any TC+ sample is also E. coli-positive (EC+), then the EC+ sample result must be reported to the state by the end of the month that the PWS is notified.

- A. True
- B. False

97. If any routine sample is TC+, repeat samples are required. – PWSs on quarterly or annual monitoring must take a minimum of one additional routine samples (known as additional routine monitoring) the quarter following a TC+ routine or repeat sample.

- A. True
- B. False

98. Total coliform samples must be collected by PWSs at sites which are representative of water quality throughout the distribution system according to a written sample siting plan subject to state review and revision.

- A. True
- B. False

99. For PWSs collecting more than one sample per month, collect total coliform samples at regular intervals throughout the month, except that ground water systems serving 4,900 or fewer people may collect all required samples on a single day if the samples are taken from different sites.

- A. True
- B. False

100. Each total coliform-positive (TC+) routine sample must be tested for the presence of autotrophic bacteria.

- A. True
- B. False

101. Reduced monitoring is general available for PWSs using only surface water and serving 1,000 or fewer persons that meet certain additional PWS criteria.

- A. True      B. False

### **Dangerous Waterborne Microbes**

102. Which of the following is a parasite that enters lakes and rivers through sewage and animal waste. It causes cryptosporidiosis, a mild gastrointestinal disease. The disease can be severe or fatal for people with severely weakened immune systems.

- A. Coliform Bacteria    C. Giardia lamblia  
B. Cryptosporidium    D. None of the above

103. Which of the following are microscopic organisms that live in the intestines of warm-blooded animals? They also live in the waste material, or feces, excreted from the intestinal tract. When fecal coliform bacteria are present in high numbers in a water sample, it means that the water has received fecal matter from one source or another.

- A. Fecal coliform bacteria    C. Shigella dysenteriae  
B. Cryptosporidium          D. None of the above

104. Which of the following are common in the environment and are generally not harmful? However, the presence of these bacteria in drinking water are usually a result of a problem with the treatment system or the pipes which distribute water, and indicates that the water may be contaminated with germs that can cause disease.

- A. Coliform Bacteria    C. Giardia lamblia  
B. Cryptosporidium    D. None of the above

105. Which of the following are bacteria whose presence indicates that the water may be contaminated with human or animal wastes? Microbes in these wastes can cause short-term effects, such as diarrhea, cramps, nausea, headaches, or other symptoms.

- A. Fecal Coliform and E. coli          C. Shigella dysenteriae  
B. Cryptosporidium                      D. None of the above

106. Which of the following are not necessarily agents of disease may indicate the presence of disease-carrying organisms?

- A. Fecal coliform bacteria    C. Shigella dysenteriae  
B. Cryptosporidium          D. None of the above

107. Which of the following is a parasite that enters lakes and rivers through sewage and animal waste. It causes gastrointestinal illness (e.g. diarrhea, vomiting, and cramps)?

- A. Coliform Bacteria    C. Protozoa  
B. Cryptosporidium    D. None of the above

108. Which of the following is a species of the rod-shaped bacterial genus Shigella?

- A. Fecal coliform bacteria    C. Shigella dysenteriae  
B. Cryptosporidium          D. None of the above

109. Which of the following can cause bacillary dysentery?

- A. Fecal coliform bacteria    C. Shigella  
B. Cryptosporidium          D. None of the above

110. Which of the following are Gram-negative, non-spore-forming, facultatively anaerobic, non-motile bacteria?

- A. Fecal coliform bacteria    C. Shigellae  
B. Cryptosporidium          D. None of the above

## Water Microbiology Section

111. \_\_\_\_\_ considered the idea that tobacco mosaic disease might be caused by a soluble agent, but he concluded incorrectly that a new type of bacteria was likely to be the cause.
- A. Adolf Mayer                      C. Robert Koch  
B. Martinus Beijerinck            D. None of the above
112. Who was the Russian scientist that extended Mayer's observation and reported in 1892 that the tobacco mosaic agent was small enough to pass through a porcelain filter known to block the passage of bacteria?
- A. Louis Pasteur                      C. Dimitri Ivanofsky  
B. Martinus Beijerinck            D. None of the above
113. Who was the famous German scientist with the British surgeon Joseph Lister that developed techniques for growing cultures of single organisms that allowed the assignment of specific bacteria to specific diseases?
- A. Louis Pasteur                      C. Robert Koch  
B. Martinus Beijerinck            D. None of the above
114. The first experimental transmission of a viral infection was accomplished by which German scientist when he demonstrated that extracts from infected tobacco leaves could transfer tobacco mosaic disease to a new plant, causing spots on the leaves?
- A. Louis Pasteur                      C. Wendell Meredith Stanley  
B. Adolf Mayer                      D. None of the above
115. Who was the French-Canadian scientist who discovered that viruses of bacteria, which he named bacteriophage, could make holes in a culture of bacteria?
- A. Louis Pasteur                      C. Walter Reed  
B. Félix H. d'Hérelle            D. None of the above
116. Who is the American biochemist that crystallized tobacco mosaic virus to demonstrate that viruses had regular shapes, and in 1939 tobacco mosaic virus was first visualized using the electron microscope?
- A. Louis Pasteur                      C. Wendell Meredith Stanley  
B. Adolf Mayer                      D. None of the above
117. In 1898 the German bacteriologists Friedrich August Johannes Löffler and Paul F. Frosch (both trained by this famous scientist described foot-and-mouth disease virus as the first filterable agent of animals?
- A. Adolf Mayer                      C. Robert Koch  
B. Martinus Beijerinck            D. None of the above
118. In 1900, the American bacteriologist \_\_\_\_\_ and colleagues recognized yellow fever virus as the first human filterable agent.
- A. Walter Reed                      C. Louis Pasteur  
B. Wendell Meredith Stanley    D. None of the above
119. Viruses were once referred to as filterable agents, and gradually the term virus (Latin for "\_\_\_\_\_ " or "poison") was employed strictly for this new class of infectious agents.
- A. Slimy liquid                      C. Macroorganisms  
B. Bacteriophages                D. None of the above
120. Through the 1940s and 1950s, many critical discoveries were made about viruses through the study of \_\_\_\_\_ because of the ease with which the bacteria they infect could be grown in the laboratory.



- A. Cell culture systems
- B. Bacteriophages
- C. Macroorganisms
- D. None of the above

121. Between 1948 and 1955, scientists at the National Institutes of Health (NIH) and at Johns Hopkins Medical Institutions revolutionized the study of animal viruses by developing \_\_\_\_\_ that permitted the growth and study of many animal viruses in laboratory dishes.

- A. Cell culture systems
- B. Bacteriophages
- C. Macroorganisms
- D. None of the above

122. Louis Pasteur along with which scientist developed the germ theory of disease that states that "a specific disease is caused by a specific type of microorganism?"

- A. Robert Koch
- B. Matthias Schleiden
- C. Rudolph Virchow
- D. None of the above

123. Who postulates not only proved the germ theory but also gave a tremendous boost to the development of microbiology by stressing a laboratory culture and identification of microorganisms?

- A. Robert Koch
- B. Matthias Schleiden
- C. Rudolph Virchow
- D. None of the above

124. Who observed small empty chambers in the structure of cork with the help of his crude microscope. He called them cells?

- A. Robert Hooke
- B. Matthias Schleiden
- C. Rudolph Virchow
- D. None of the above

125. Two German biologists \_\_\_\_\_ and Theodore Schwann proposed the "Cell theory" in 1838. According to this theory, all living things are composed of cells.

- A. Robert Hooke
- B. Matthias Schleiden
- C. Rudolph Virchow
- D. None of the above

126. \_\_\_\_\_ completed the cell theory with the idea that all cells must arise from preexisting cells.

- A. Theodore Schwann
- B. Matthias Schleiden
- C. Rudolph Virchow
- D. None of the above

127. In the world of bacteria, there is even a species of *Deinococcus radiodurans*—that can withstand blasts of radiation 10 times greater than would kill a human being.

- A. True
- B. False

### **Bacteria**

128. "Bacteria" is a plural word. The singular for this word is "bacterium" (bacter = rod, staff).

- A. True
- B. False

129. Bacteria are prokaryotes (Kingdom Monera), which means that they have No true nucleus. They do have one chromosome of double-stranded DNA in a ring.

- A. True
- B. False

130. There are some bacteria relatives that can do photosynthesis--they don't have chloroplasts, but their \_\_\_\_\_ and other needed chemicals are built into their cell membranes.

- A. Chlorophyll
- B. An organelle
- C. Cellulose
- D. None of the above

131. Bacteria consist of only \_\_\_\_\_?  
A. A single cell      C. Double-stranded DNA  
B. An organelle      D. None of the above

132. Pathogens have been found that can live in temperatures above the boiling point and in cold that would freeze your blood. They "eat" everything from sugar and starch to sunlight, sulfur and iron.  
A. True      B. False

### Prokaryotes

133. The only prokaryotes are Bacteria and archaea all other life forms are \_\_\_\_\_ creatures whose cells have nuclei.  
A. Bacteria      C. Eukaryotes  
B. Microorganism      D. None of the above

### Early Origins

134. Bacteria, are basically one of three different shapes, some are rod - or stick-shaped and called Bacilli. Others are shaped like little balls and called cocci (cox-eye).  
A. True      B. False

135. Bacterial cells exist as cluster together to form pairs, chains, squares or other groupings.  
A. True      B. False

136. The mitochondria that make energy for your body cells is one example of?  
A. Chloroplasts      C. Chemical battery  
B. Cellulose      D. None of the above

137. A single teaspoon of topsoil may contain more than a billion (1,000,000,000) bacteria.  
A. True      B. False

### Peptidoglycan

138. The amount and location of the \_\_\_\_\_ are different in the two possible types of cell walls, depending on the species of bacterium.

- A. Capsule      C. Cytoplasmic granules  
B. Peptidoglycan      D. None of the above

139. Penicillin, inhibit the formation of the chemical cross linkages needed to make?  
A. Bacteria      C. Cytoplasmic granules  
B. Peptidoglycan      D. None of the above

140. If a person stops an antibiotic, any living bacteria could start making \_\_\_\_\_, grow, and reproduce.

- A. Bacteria      C. Cytoplasmic granules  
B. Peptidoglycan      D. None of the above

### Gram Stain

141. Two possible types of \_\_\_\_\_ may have more peptidoglycan than the other.

- A. Bacteria      C. Bacterial cell walls  
B. Chemical cross linkages      D. None of the above

142. In the Gram process, the amount of peptidoglycan in the cell walls of the bacteria under study will determine how those bacteria absorb the dyes with which they are stained; thus, bacterial cells can be Gram<sup>+</sup> or Gram<sup>-</sup>.

- A. True      B. False

143. Which type of bacteria have simpler cell walls with lots of peptidoglycan, and stain a dark purple color?

- A. Aerobic
- B. Gram<sup>-</sup>
- C. Gram<sup>+</sup>
- D. None of the above

144. Which type of bacteria have more complex cell walls with less peptidoglycan, thus absorb less of the purple dye used and stain a pinkish color?

- A. Aerobic
- B. Gram<sup>-</sup>
- C. Gram<sup>+</sup>
- D. None of the above

145. Which type of bacteria often incorporate toxic chemicals into their cell walls, and thus tend to cause worse reactions in our bodies?

- A. Aerobic
- B. Gram<sup>-</sup>
- C. Gram<sup>+</sup>
- D. None of the above

146. Which of the bacteria have less peptidoglycan, antibiotics like penicillin are less effective against them?

- A. Aerobic
- B. Gram<sup>-</sup>
- C. Gram<sup>+</sup>
- D. None of the above

147. Pseudomonas aeruginosa is a strictly aerobic, oxidase positive, non-fermentative bacterium are?

- A. Aerobic
- B. Gram<sup>-</sup>
- C. Gram<sup>+</sup>
- D. None of the above

148. With the Gram-stain, appearance is not particularly characteristic although rods are somewhat thinner than those seen for the?

- A. Coliform bacteria
- B. Enteric-like bacteria
- C. Standard plate count
- D. None of the above

### Two types of cells- Prokaryotes and Eukaryotes

149. Which of the following exhibits all the characteristics of life but it lacks the complex system of membranes and organelles?

- A. Prokaryotic cell
- B. Enteric-like bacteria
- C. Coliform bacteria
- D. None of the above

### Structure of a Eukaryotic Cell

150. Cell Membrane: The cell is enclosed and held intact by the cell membrane/plasma membrane/cytoplasmic membrane and is composed of large molecules of proteins and?

- A. Cytoplasmic granules
- B. Cell wall
- C. Phospholipids
- D. None of the above

151. Which of the following is selectively permeable?

- A. Cytoplasmic granules
- B. DNA and proteins
- C. Cellular membrane
- D. None of the above

### Nucleus

152. Which of the following is enclosed in the nuclear membrane and contains chromosomes?

- A. Chromosomes
- B. Nucleus
- C. Macromolecular polymer-peptidoglycan
- D. None of the above

153. A single circular DNA molecule consists of many genes. A gene is a coiled unit made up of Cytoplasmic granules and proteins that code for or determine a particular characteristic of an individual organism.

- A. True
- B. False

### Cytoplasm

154. Cytoplasm is comprised of a semifluid gelatinous nutrient matrix and cytoplasmic organelles including endoplasmic reticulum, ribosomes, Golgi complex, mitochondria, \_\_\_\_\_, microtubules, lysosomes and vacoules.

- A. Chromosomes
- B. Procaryotes
- C. Centrioles
- D. None of the above

### Cilia and Flagella

155. Which of the following reflect cells that possess relatively long and thin structures called Flagella?

- A. Eukaryotic
- B. Paramecium
- C. Prokaryotic
- D. None of the above

156. Which of the following are organs of locomotion but are shorter and more numerous?

- A. Cytoplasmic granules
- B. Cilia
- C. Flagellin
- D. None of the above

### Structure of a Prokaryotic Cell

157. All bacteria are prokaryotes and are simple cells and they divide by binary fission.

- A. True
- B. False

### Chromosome

158. The chromosome of a prokaryotic cell normally consists of a single circular \_\_\_\_\_ and serves as the control center of the bacterial cell.

- A. Cytoplasmic granules
- B. DNA molecule
- C. Singular circular DNA molecule
- D. None of the above

159. A characteristic bacterial chromosome contains approximately 10,000 genes.

- A. True
- B. False

### Cytoplasm

160. Which of the following is a semi-liquid that surrounds the chromosome and is contained within the plasma membrane?

- A. Eukaryotic cell membrane
- B. Cytoplasm
- C. Macromolecular polymer-peptidoglycan
- D. None of the above

### Capsules

161. Some bacteria have a layer of material outside the?

- A. Capsule
- B. Cell wall
- C. Membrane/cytoplasmic membrane
- D. None of the above

162. Which of the following terms consist of complex sugars or polysaccharides combined with lipids and proteins?

- A. Capsule
- B. Cell wall
- C. Membrane/cytoplasmic membrane
- D. None of the above

### Flagella

163. Flagella are \_\_\_\_\_ that enable the bacteria to move.

- A. Forming spores
- B. Cilia
- C. False feet
- D. None of the above

164. Which term is motile while non-flagellated bacteria are generally non-motile?

- A. Bacteria
- B. Peptidoglycan
- C. Flagellated bacteria
- D. None of the above

165. Peritrichous bacteria- possess?  
A. One flagellum                      C. Flagella over the entire surface  
B. A single polar flagellum      D. None of the above

166. Amphitrichous bacteria-bacteria with \_\_\_\_\_.  
A. One flagellum                      C. One flagellum at each end  
B. A single polar flagellum      D. None of the above

167. Monotrichous bacteria-bacteria with \_\_\_\_\_.  
A. One flagellum                      C. Flagella over the entire surface  
B. A single polar flagellum      D. None of the above

168. Lophotrichous bacteria-possess at one or both ends?  
A. One flagellum                      C. Flagella over the entire surface  
B. Tuft of flagella                  D. None of the above

### **Pili or Fimbriae**

169. Pili or Fimbriae allow the bacteria to attach to other bacteria or to membrane surfaces such as intestinal linings or?

- A. Chromosomes                      C. Pili or Fimbriae  
B. RBC                                      D. None of the above

170. Which of the following terms is used to transfer genetic material from one bacteria cell to another?  
A. Chromosomes                      C. Pili or Fimbriae  
B. RBC                                      D. None of the above

### **Spores**

171. Which of the following is enclosed in several protein coats that are resistant to heat, drying and most chemicals?

- A. Spores                                      C. Spore formation  
B. Genetic material                      D. None of the above

172. Spore formation is related to the survival of bacterial cells, not reproduction.  
A. True                      B. False

### **Bacterial Nutrition**

173. Which of the following is needed in substantial quantities, but some seem to need it in trace amounts?

- A. Iron, Zinc, Cobalt                      C. Calcium  
B. Nitrogen                                      D. None of the above

174. Which of the following terms all life requires in order to grow and reproduce?

- A. Water                                      C. Copper  
B. Calcium                                      D. None of the above

175. All life has the same basic nutritional requirements that include: Energy. This may be light or inorganic substances like sulfur, carbon monoxide or ammonia, or preformed organic matter like sugar, protein, fats etc.

- A. True                      B. False

176. Which of the following may be in these forms- nitrogen gas, ammonia, nitrate/nitrite, or a nitrogenous organic compound like protein or Nucleic acid?

- A. Nitrites                                      C. Nitrates  
B. Nitrogen                                      D. None of the above

177. Which of the following may be in these forms- carbon dioxide, methane, carbon monoxide, or a complex organic material?

- A. Nitrogen
- B. Carbon
- C. Oxygen
- D. None of the above

### **Fastidious**

178. Which of the following may synthesize every complex molecule they need from the basic minerals?

- A. Viruses
- B. Bacteria
- C. Centrioles
- D. None of the above

### **What in the World is an Eukaryote?**

179. Which of the following terms represents animals, plants, and fungi, which are mostly multicellular, as well as various other groups called protists, many of which are unicellular?

- A. Eukaryote(s)
- B. Bacteria
- C. Prokaryote(s)
- D. None of the above

180. The eukaryotes share a common origin, and are treated formally as a super kingdom, empire, or domain.

- A. True
- B. False

### **Eukaryotic Cells**

181. According to the text, Eukaryotic cells are generally much larger than \_\_\_\_\_, typically with a thousand times their volumes.

- A. Macroorganisms
- B. Bacteria
- C. Prokaryote(s)
- D. None of the above

182. Which of the following represents a variety of Internal membranes and structures, called organelles, and a cytoskeleton composed of microtubules and microfilaments?

- A. Eukaryote(s)
- B. Bacteria
- C. Prokaryote(s)
- D. None of the above

183. Which of the following represent DNA that is divided into several bundles called chromosomes, which are separated by a microtubular spindle during nuclear division?

- A. Eukaryote(s)
- B. Bacteria
- C. Prokaryote(s)
- D. None of the above

184. Many cells ingest food and other materials through a process of osmosis, where the outer membrane invaginates and then pinches off to form a Flagella.

- A. True
- B. False

185. Which of the following is surrounded by a double membrane with pores that allow material to move in and out?

- A. The nucleus
- B. Flagella
- C. Cilia
- D. None of the above

### **Protozoan Reservoirs of Disease**

186. Which of the following represents the causative organism of Legionnaires' disease?

- A. Amoebae
- B. Viruses
- C. Bacterium Legionella pneumophila
- D. None of the above

187. The presence of bacteria in the cytoplasm of protozoa is well known, whereas that of viruses is less frequently reported. Most of these reports simply record the presence of bacteria or viruses and assume some sort of symbiotic relationship between them and the Protozoa.

- A. True
- B. False

188. Which of the following were shown to not only survive but also to multiply in the cytoplasm of free-living, nonpathogenic protozoa?

- A. Human pathogens
- B. Marine protozoa
- C. Freshwater protozoan
- D. None of the above

189. Protozoa are the natural habitat for certain pathogenic bacteria.

- A. True
- B. False

### Symbionts

190. Which of the following terms inhabit the rumen and reticulum of ruminates and the cecum and colon of equids?

- A. Ciliates
- B. Marine protozoa
- C. Freshwater protozoan
- D. None of the above

### Data on Protozoa

191. Most ecologists who include \_\_\_\_\_ in their studies of aquatic habitats do not identify them, even if they do count and measure them for biomass estimates.

- A. Protozoa
- B. Marine protozoa
- C. Freshwater protozoan
- D. None of the above

192. Which of the following terms represents an organism of humans, domestic animals, and wildlife are better known although no attempt has been made to compile this information into a single source?

- A. Protozoa
- B. Marine protozoa
- C. Parasitic protozoa
- D. None of the above

### Ecological Role of Protozoa

193. Which of the following terms represents an organism that is frequently overlooked, these play an important role in many communities where they occupy a range of trophic levels?

- A. Protozoa
- B. Marine protozoa
- C. Parasitic protozoa
- D. None of the above

194. According to the text, these are predators of unicellular or filamentous algae, \_\_\_\_\_, and microfungi, protozoa play a role both as herbivores and as consumers in the decomposer link of the food chain.

- A. Ciliates
- B. Bacteria
- C. Freshwater protozoan
- D. None of the above

195. The ecological role of Foraminifera in the transfer of bacterial and algal production to successive trophic levels is important.

- A. True
- B. False

### Factors Affecting Growth and Distribution

196. Which of the following reproduce by cell division?

- A. Most free-living protozoa
- B. Parasites
- C. Trophozoites and cysts
- D. None of the above

### Protozoa

197. When protozoa are in the form of \_\_\_\_\_, they actively feed and grow.

- A. Cysts
- B. Trophozoites
- C. Apicomplexans
- D. None of the above

(S) Means the answer can be plural or singular in nature

198. Which of the following play a role both as herbivores and as consumers in the decomposer link of the food chain?

- A. Protozoa
- B. Zygotes
- C. Trophozoites and cysts
- D. None of the above

199. Which of the following are an important food source for microinvertebrates?

- A. Zygotes
- B. Protozoa
- C. Microinvertebrates
- D. None of the above

200. According to the text, the process by which the protozoa takes its cyst form is called encystation, while the process of transforming back into \_\_\_\_\_ is called excystation.

- A. Cysts
- B. Trophozoite
- C. Apicomplexans
- D. None of the above

201. Protozoa occupy a range of trophic levels, as predators, they prey upon unicellular or filamentous algae, bacteria, and?

- A. Microfungi
- B. Parasites
- C. Trophozoites and cysts
- D. None of the above

202. Most protozoa exist in 5 stages of life which are in the form of \_\_\_\_\_.

- A. Zygotes
- B. Parasites
- C. Trophozoites and cysts
- D. None of the above

203. Which of the following can survive harsh conditions, such as exposure to extreme temperatures and harmful chemicals, or long periods without access to nutrients, water, or oxygen for a period of time.

- A. Meiofauna
- B. Protozoa
- C. Microinvertebrates
- D. None of the above

204. An individual protozoan is?

- A. Apicomplexans
- B. Trophozoite
- C. Hermaphroditic
- D. None of the above

### Classification

205. Protozoa were usually grouped in the kingdom of Protista together with the plant-like algae and fungus-like water molds and slime molds. In the 21st-century systematics, protozoans, along with ciliates, mastigophorans, and apicomplexans, are arranged as animal-like protists.

- A. True
- B. False

206. Protozoans are neither Animalia nor Metazoa.

- A. True
- B. False

### Bacteriophage

207. Bacteriophages are much larger than the bacteria they destroy.

- A. True
- B. False

208. Phages are estimated to be the most widely distributed and diverse entities in the biosphere.

- A. True
- B. False

209. Phages are not usually found in all reservoirs populated by bacterial hosts, such as soil or the intestine of animals.

- A. True
- B. False



## Amoebas

210. Pseudopods are used to capture prey; they simply engulf the food. They can detect the kind of prey and use different?

- A. Cells
- B. Cytoplasm
- C. Engulfing tactics
- D. None of the above

## Protozoa Information

211. Which of the following have been documented from almost every type of soil and in every kind of environment, from the peat-rich soil of bogs to the dry sands of deserts?

- A. Soil-dwelling protozoa
- B. Protozoan fauna
- C. Soil-loving Amoeba
- D. None of the above

212. In freshwater habitats, the foraminifera and radiolaria common in marine environments are absent or low in numbers while \_\_\_\_\_ exist in greater numbers.

- A. Microsporidia
- B. Testate amoebae
- C. Protozoan fauna
- D. None of the above

## Environmental Quality Indicators

213. Polluted waters often have a rich and characteristic?

- A. Microsporidia
- B. Testate amoebae
- C. Protozoan fauna
- D. None of the above

## Symbiotic Protozoa

### Parasites

214. Which term means a unique group of obligate, intracellular parasitic protozoa?

- A. Microsporidia
- B. Testate amoebae
- C. Protozoan fauna
- D. None of the above

215. There are four different genera of microsporidia (Encephalitozoon, Nosema, Pleistophora, and \_\_\_\_\_).

- A. Foraminifera
- B. Protozoan fauna
- C. Enterocytozoon
- D. None of the above

216. The presence of bacteria in \_\_\_\_\_ is well known, whereas that of viruses is less frequently reported.

- A. Foraminifera
- B. Protozoan fauna
- C. Cytoplasm of protozoa
- D. None of the above

217. The presence of bacteria or viruses and assume some sort of symbiotic relationship between them and the?

- A. Protozoa
- B. Bacteria or viruses
- C. Free-living amoebae
- D. None of the above

218. Some human pathogens were shown to not only survive but also to multiply in the cytoplasm of free-living?

- A. Beneficial symbionts
- B. Organisms
- C. Nonpathogenic protozoa
- D. None of the above

219. To date, the focus of attention has been on the \_\_\_\_\_, the causative organism of Legionnaires' disease; these bacteria live and reproduce in the cytoplasm of some free-living amoebae.

- A. Free-living amoebae
- B. Bacteria or viruses
- C. Bacterium Legionella pneumophila
- D. None of the above

## Symbionts

220. According to the text, which of these creatures are harmless or even beneficial symbionts?

- A. Protozoa
- B. Viruses
- C. Bacterium *Legionella pneumophila*
- D. None of the above

### Contractile Vacuoles

221. Many protozoa have \_\_\_\_\_, which collect and expel excess water, and extrusomes, which expel material used to deflect predators or capture prey.

- A. Flagella
- B. Contractile vacuoles
- C. Vacuole or tonoplast
- D. None of the above

222. In higher plants, most of a cell's volume is taken up by a central vacuole or tonoplast, which maintains its?

- A. Kinetosome or centriole
- B. Vacuole or tonoplast
- C. Osmotic pressure
- D. None of the above

223. Which of the following have slender motile projections, usually called flagella when long and cilia when short?

- A. Eukaryote(s)
- B. Bacteria
- C. Prokaryote(s)
- D. None of the above

224. Which bug/creature/organism are entirely distinct from prokaryotic flagella?

- A. Eukaryote(s)
- B. Bacteria
- C. Prokaryote(s)
- D. None of the above

225. Flagella also may have hairs or mastigonemes, scales, connecting membranes, and internal rods, their interior is continuous with the?

- A. Flagella
- B. Haptonema
- C. Cell's cytoplasm
- D. None of the above

### Centrioles

226. Centrioles are often present even in cells and groups that do not have flagella. They generally occur in groups of one or two, called \_\_\_\_\_ that give rise to various microtubular roots.

- A. Kinetosome or centriole
- B. Kinetids
- C. Beneficial symbionts
- D. None of the above

227. These form a primary component of the \_\_\_\_\_, and are often assembled over the course of several cell divisions, with one flagellum retained from the parent and the other derived from it.

- A. Centrioles
- B. Haptonema
- C. Cytoskeletal structure
- D. None of the above

228. Which of the following may also be associated in the formation of a spindle during nuclear division?

- A. Centrioles
- B. Haptonema
- C. Cytoskeletal structure
- D. None of the above

229. Which of the following produces axopodia that is used in flotation or to capture prey, and the haptophytes, which have a peculiar flagellum-like organelle called the haptonema?

- A. Paramecium
- B. Haptonema
- C. Radiolaria and heliozoa
- D. None of the above

(S) Means the answer can be plural or singular in nature

### Paramecium

230. Which of the following are single-celled, freshwater organisms in the kingdom Protista?

- A. Paramecium
- B. Bacteria
- C. Prokaryote(s)
- D. None of the above

231. Paramecium exist in an environment in which the osmotic concentration in their external environment is much lower than that in their?

- A. Contractile vacuoles
- B. Haptonema
- C. Cytoplasm
- D. None of the above

232. If Paramecium is to maintain \_\_\_\_\_, water must be continually pumped out of the cell at the same rate at which it moves in.

- A. Life
- B. Happiness
- C. Homeostasis
- D. None of the above

233. Osmoregulation, is carried out by two organelles in Paramecium known as?

- A. Kinetosome or centriole
- B. Vacuole or tonoplast
- C. Contractile vacuoles
- D. None of the above

### Bacteriological Monitoring Introduction

234. Which of the following are usually harmless, occur in high densities in their natural environment and are easily cultured in relatively simple bacteriological media?

- A. Indicator bacteria
- B. Amoebas
- C. Viruses
- D. None of the above

235. Indicators in common use today for routine monitoring of drinking water include total coliforms, fecal coliforms, and?

- A. Cryptosporidium
- B. Protozoa
- C. Escherichia coli (E. coli)
- D. None of the above

236. According to the text, the routine microbiological analysis of your water is for?

- A. Contamination
- B. Colloids
- C. Coliform bacteria
- D. None of the above

### Bacteria Sampling

237. Water samples for \_\_\_\_\_ must always be collected in a sterile container.

- A. Amoebas
- B. Bacteria tests
- C. Viruses
- D. None of the above

### Methods

238. The MMO-MUG test, a product marketed as \_\_\_\_\_, is the most common. The sample results will be reported by the laboratories as simply coliforms present or absent.

- A. Colilert
- B. Coliform
- C. Total coliform analysis
- D. None of the above

### Microbial Regulations

239. One of the key regulations developed and implemented by the United States Environmental Protection Agency (USEPA) to counter pathogens in drinking water is the Surface Water Treatment Rule.

- A. True
- B. False

(S) Means the answer can be plural or singular in nature

240. Among Surface Water Treatment Rule provisions, the rule requires that a public water system, using surface water (or ground water under the direct influence of surface water) as its source, have sufficient treatment to reduce the source water concentration of protozoa and coliform bacteria by at least 99.9% and 99.99%, respectively.

- A. True                      B. False

241. The Surface Water Treatment Rule suggests treatment criteria to assure that these performance recommendations are met; they may include turbidity limits, disinfectant residual and disinfectant contact time conditions.

- A. True                      B. False

### **Basic Types of Water Samples**

242. It is important to properly identify the type of sample you are collecting.

- A. True                      B. False

### **The three (3) primary types of samples are:**

243. A PWS incurs an E. coli MCL violation.

- A. Trigger: Level 1 Assessment      C. All of the above  
B. Trigger: Level 2 Assessment      D. None of the above

244. A PWS collecting fewer than 40 samples per month has 2 or more TC+ routine/ repeat samples in the same month.

- A. Trigger: Level 1 Assessment      C. All of the above  
B. Trigger: Level 2 Assessment      D. None of the above

245. Samples collected following a coliform present routine sample. The number of repeat samples to be collected is based on the number of \_\_\_\_\_ samples you normally collect.

- A. Repeat      C. Routine  
B. Special      D. None of the above

246. A PWS fails to take every required repeat sample after any single TC+ sample

- A. Trigger: Level 1 Assessment      C. All of the above  
B. Trigger: Level 2 Assessment      D. None of the above

247. A PWS collecting at least 40 samples per month has greater than 5.0 percent of the routine/repeat samples in the same month that are TC+.

- A. Trigger: Level 1 Assessment      C. All of the above  
B. Trigger: Level 2 Assessment      D. None of the above

248. A PWS has a second Level 1 Assessment within a rolling 12-month period.

- A. Trigger: Level 1 Assessment      C. All of the above  
B. Trigger: Level 2 Assessment      D. None of the above

249. A PWS on state-approved annual monitoring has a Level 1 Assessment trigger in 2 consecutive years.

- A. Trigger: Level 1 Assessment      C. All of the above  
B. Trigger: Level 2 Assessment      D. None of the above

250. Noncommunity and nontransient noncommunity public water systems will sample at the same frequency as a like sized community public water system if:

1. It has more than 1,000 daily population and has ground water as a source, or
2. It serves 25 or more daily population and utilizes surface water as a source or ground water under the direct influence of surface water as its source.

- A. True                      B. False

251. Noncommunity and nontransient, noncommunity water systems with less than 10,000 daily population and groundwater as a source will sample on an annual basis.

- A. True      B. False

### **Maximum Contaminant Levels (MCLs)**

252. State and federal laws establish standards for drinking water quality. Under normal circumstances when these standards are being met, the water is safe to drink with no threat to human health. These standards are known as maximum contaminant levels (MCL). When a particular contaminant exceeds its MCL a potential health threat may occur.

- A. True      B. False

253. The MCLs are based on extensive research on toxicological properties of the contaminants, risk assessments and factors, short-term (acute) exposure, and long-term (chronic) exposure. You conduct the monitoring to make sure your water is in compliance with the MCL.

- A. True      B. False

254. There are two types of MCL violations for coliform bacteria. The first is for total coliform; the second is an acute risk to health violation characterized by the confirmed presence of fecal coliform or E. coli.

- A. True      B. False

### **Positive or Coliform Present Results**

255. If you are notified of a positive coliform test result you need to contact either the Drinking Water Program or your local county health department within 72 hours, or by the next business day after the MCL compliance violation

- A. True      B. False

256. With a positive total coliform sample, after you have contacted an agency for assistance, you will be instructed as to the proper repeat sampling procedures and possible corrective measures for solving the problem. It is very important to initiate the \_\_\_\_\_ as the corrective measures will be based on those results.

- A. Perform routine procedures      C. Corrective measures  
B. Repeat sampling immediately      D. None of the above

### **Heterotrophic Plate Count HPC**

257. Heterotrophic Plate Count (HPC) --- formerly known as the Bac-T plate, is a procedure for estimating the number of live heterotrophic bacteria and measuring changes during water treatment and distribution in water or in swimming pools.

- A. True      B. False

### **Heterotrophic Plate Count (Spread Plate Method)**

258. Which of the following provides a technique to quantify the bacteriological activity of a sample?

- A. Colonies      C. Heterotrophic Plate Count  
B. Agar      D. None of the above

### **Total Coliforms**

259. This MCL is based on the presence of total coliforms, and compliance is on a daily or weekly basis, depending on your water system type and state rule.

- A. True      B. False

260. For systems which collect fewer than \_\_\_\_\_ samples per month, no more than one sample per month may be positive. In other words, the second positive result (repeat or routine) in a month or quarter results in a MCL violation.

- A. 40      C. 200  
B. 100      D. None of the above

**The following are acute violations:**

261. Which determines a violation of nitrate?

- A. Presence C. MCLG
- B. MCL D. None of the above

**Revised Total Coliform Rule (RTCR) Summary**

262. The water provider shall develop and follow a sample-siting plan that designates the PWS's collection schedule. This includes location of \_\_\_\_\_.

- A. Routine and repeat water samples C. Microbial contamination
- B. Reduced monitoring D. Repeat water samples

263. The water provider shall collect \_\_\_\_\_ on a regular basis (monthly, quarterly, annually).

- A. Routine water samples C. Microbial contamination
- B. Reduced monitoring D. Repeat water samples

264. Have samples tested for the presence of total coliforms by a state certified laboratory.

- A. True B. False

265. PN is required for violations incurred. Within required timeframes, the PWS must use the required health effects language and notify the public if they did not comply with certain requirements of the RTCR. The type of \_\_\_\_\_ depends on the severity of the violation.

- A. CCR(s) C. MCL violation
- B. PN D. TC+ routine or repeat sample

266. EPA published the Revised Total Coliform Rule (RTCR) in the Federal Register (FR) on February 13, 2013 (78 FR 10269). It is the revision to the 1989 Total Coliform Rule (TCR).

- A. True B. False

267. The RTCR upholds the purpose of the 1989 TCR to protect public health by ensuring the duplicity of the drinking water distribution system and monitoring for the absence of microbial contamination.

- A. True B. False

268. The RTCR establishes criteria for systems to qualify for and stay on for special increased monitoring, which could reduce water system problems for better system operation.

- A. True B. False

269. The RTCR requires public water systems that are vulnerable to microbial contamination to identify and fix problems.

- A. True B. False

270. The water provider shall collect repeat samples (at least 3) for each TC+ positive routine sample.

- A. True B. False

271. For PWSs on quarterly or annual routine sampling, collect additional routine samples (at least 3) in the month after a \_\_\_\_\_.

- A. CCR(s) C. Total coliform positive samples
- B. PN D. TC+ routine or repeat sample

272. PWSs incur violations if they do not comply with the requirements of the RTCR. The violation types are essentially the same as under the TCR with few changes. The biggest change is no acute or monthly MCL violation for \_\_\_\_\_ only.

- A. CCR(s) C. Total coliform positive samples
- B. PN D. TC+ routine or repeat sample

273. Community water systems (CWSs) must use specific language in their CCRs when they must conduct an assessment or if they incur \_\_\_\_\_.

- A. CCR(s)
- B. PN
- C. An E. coli MCL violation
- D. TC+ routine or repeat sample

274. The water provider shall analyze all \_\_\_\_\_ that are total coliform positive (TC+) for E. coli.

- A. Routine or repeat water samples
- B. Reduced monitoring
- C. Microbial contamination
- D. Repeat water samples

275. The RTCR requires public water systems (PWSs) to meet a legal limit for E. coli, as demonstrated by required monitoring.

- A. True
- B. False

276. The RTCR suggests the frequency and timing of required microbial testing based on, public water type and source water type.

- A. True
- B. False

### Disinfection Key

277. The RTCR requires 99.99% or 4 log inactivation of \_\_\_\_\_.

- A. Enteric viruses
- B. Crypto
- C. Giardia lamblia cysts
- D. None of the above

278. The RTCR requires 99% or 2 log inactivation of \_\_\_\_\_.

- A. Enteric viruses
- B. Crypto
- C. Giardia lamblia cysts
- D. None of the above

279. The RTCR requires 99.9% or 3 log inactivation of \_\_\_\_\_.

- A. Enteric viruses
- B. Crypto
- C. Giardia lamblia cysts
- D. None of the above

280. The RTCR requires the chlorine residual leaving the plant must be = or \_\_\_\_\_ mg/L and measurable throughout the system.

- A. > 0.2
- B. 2.0
- C. 0.2
- D. None of the above

### Waterborne Pathogen Section

#### Pathogen Section

281. Most pathogens are generally associated with diseases that \_\_\_\_\_ and affect people in a relatively short amount of time, generally a few days to two weeks.

- A. Cause intestinal illness
- B. Are mild in nature
- C. Will cause fatalities
- D. None of the above

#### How Diseases are Transmitted.

282. Waterborne pathogens are primarily spread by the?

- A. Fecal-oral, or feces-to-mouth route
- B. Dermal to fecal route
- C. Oral to fecal route
- D. None of the above

#### Protozoan Caused Diseases

283. Which of the following bugs is larger than bacteria and viruses but still microscopic; they invade and inhabit the gastrointestinal tract?

- A. Hepatitis A
- B. E.coli
- C. Protozoan pathogens
- D. None of the above

284. Some of the parasites enter the environment in a dormant form, with a protective cell wall, called a?

- A. Lamblia      C. Cyst
- B. Shell        D. None of the above

### **Giardia lamblia**

285. Which of the following bugs has been responsible for more community-wide outbreaks of disease in the U.S. than any other, and drug treatment are not 100% effective?

- A. Giardia lamblia      C. Giardiasis
- B. Cryptosporidiosis    D. None of the above

286. All of these diseases, with the exception of \_\_\_\_\_, have one symptom in common: diarrhea. They also have the same mode of transmission, fecal-oral, whether through person-to-person or animal-to-person contact.

- A. HIV infection      C. Hepatitis A
- B. Giardiasis        D. None of the above

### **Primary Waterborne Diseases Section**

287. Humans are the reservoir for the Salmonella typhi pathogen, which causes diarrheal illness, and also known as?

- A. Campylobacter      C. Typhoid fever
- B. Shigella dysenteriae    D. None of the above

288. Campylobacter, the basics. It's a bacterium. It causes diarrheal illness.

- A. True      B. False

289. Campylobacter is primarily associated with poultry, animals, and humans.

- A. True      B. False

290. Vibrio cholerae, the basics. It's a virus. It causes diarrheal illness, also known as cholera. It is typically associated with aquatic environments, shell stocks, and human. Vibrio cholerae has also been associated with ship ballast water.

- A. True      B. False

291. Shigella species, in the United States two-thirds of the shigellosis in the U.S. is caused by Shigella dysenteriae and the remaining one-third is caused by Shigella Campylobacter.

- A. True      B. False

292. Legionnaire's disease, which causes a severe pneumonia, and the second, \_\_\_\_\_, which is a non-pneumonia illness; it's typically an influenza-like illness, and it's less severe.

- A. Pontiac fever      C. Typhoid fever
- B. Yellow fever      D. None of the above

293. Legionella, prevention. Legionella in water systems. Hot water in tanks should be maintained between \_\_\_\_\_ degrees Centigrade.

- A. 81 to 100      C. 71 and 77
- B. 110 to 210    D. None of the above

294. Which of the following is typically associated with soil and water?

- A. Hepatitis A virus    C. Pseudomonas
- B. Legionella          D. None of the above



295. Hepatitis A virus is resistant to combined chlorines, so it is important to have an adequate free chlorine residual. Fecal matter can shield Hepatitis A virus from chlorine.  
A. True      B. False
296. Cryptosporidium is typically associated with animals and humans, and it can be acquired through consuming fecally contaminated food, contact with fecally contaminated soil and water.  
A. True      B. False
297. Schistosomatidae prevention strategies for this pathogen include Placing boric acid on berms or interrupting the life cycle of the parasite by treating birds with a lead.  
A. True      B. False
298. Cryptosporidium, prevention. Prevention strategies for this pathogen include source protection. A CT value of 50 is required when dealing with fecally accidents. CT equals a concentration, in parts per million, while time equals a contact time in minutes.  
A. True      B. False
299. Humans are the reservoir for the Norovirus. Prevention strategies for this pathogen include?  
A. Internal protection      C. Containment protection  
B. Source protection      D. None of the above
300. Giardia prevention strategies for this pathogen include \_\_\_\_\_; filtration, coagulation, and halogenation of drinking water.  
A. Internal protection      C. Containment protection  
B. Source protection      D. None of the above
301. Schistosomatidae, the basics. It is a parasite. It is acquired through dermal contact, cercarial dermatitis. It is commonly known as?  
A. Swimmer's itch      C. Hemorrhagic colitis  
B. Beaver fever      D. None of the above

### **Waterborne Bacterial Diseases**

302. Campylobacteriosis outbreaks have most often been associated with food, especially chicken and un-pasteurized milk, as well as un-chlorinated water. These organisms are also an important cause of "travelers' diarrhea." Medical treatment generally is not prescribed for campylobacteriosis because recovery is usually rapid.  
A. True      B. False
303. Cholera, Legionellosis, salmonellosis, shigellosis, yersiniosis, are other bacterial diseases that can be transmitted through water. All bacteria in water are readily killed or inactivated with chlorine or other disinfectants.  
A. True      B. False
304. Campylobacteriosis is the most common diarrheal illness caused by bacteria. Other symptoms include abdominal pain, malaise, fever, nausea and vomiting; and begin three to five days after exposure. The illness is frequently over within two to five days and usually lasts no more than 10 days.  
A. True      B. False

### **Viruses - Coronavirus**

305. It looks like the COVID-19 coronavirus is not able to live in water.  
A. True      B. False

### Chain of Custody Procedures

306. If both parties involved in the transfer must sign, date and note the time on the chain of custody record, this is known as?

- A. TC Plan
- B. Sample siting plan
- C. Samples transfer possession
- D. None of the above

307. The recipient will then attach the \_\_\_\_\_ showing the transfer dates and times to the custody sheets. If the samples are split and sent to more than one laboratory, prepare a separate chain of custody record for each sample.

- A. Shipping invoices
- B. Chain of custody release
- C. Sample siting plan
- D. None of the above

### Factors in Chlorine Disinfection: Concentration and Contact Time

308. Based on the work of several researchers, CXT values [ final free chlorine concentration (mg/L) multiplied by minimum contact time (minutes)], offer water operators guidance in computing an effective combination of chlorine concentration and \_\_\_\_\_ required to achieve disinfection of water at a given temperature.

- A. Chlorine concentration
- B. Chlorine contact time
- C. Higher strength chlorine solutions
- D. None of the above

309. The CXT formula demonstrates that if an operator chooses to decrease the chlorine concentration, the required \_\_\_\_\_ must be lengthened.

- A. Chlorine concentration
- B. Temperature
- C. Contact time
- D. None of the above

## Escherichia Coli Section

### Fecal Coliform Bacteria

310. Fecal Coliform Bacteria live in the waste material, or feces, excreted from the intestinal tract. When fecal coliform bacteria are present in high numbers in a water sample, it means that the water has received \_\_\_\_\_ from one source or another.

- A. Bacteria levels
- B. Fecal matter
- C. Enrichment concentrations
- D. None of the above

311. Although not necessarily agents of disease, \_\_\_\_\_ may indicate the presence of disease-carrying organisms, which live in the same environment as the fecal coliform bacteria.

- A. Paramecium
- B. Bacteria
- C. Fecal coliform bacteria
- D. None of the above

### Reasons for Natural Variation

312. Which of the following is dependent on specific conditions for growth, and these conditions change quickly, fecal coliform bacteria counts are not easy to predict?

- A. Fecal matter
- B. Fecal coliform bacteria
- C. Bacterial concentrations
- D. None of the above

313. Winter rains may wash more \_\_\_\_\_ from urban areas into a stream; cool water temperatures may cause a major die-off.

- A. Fecal matter
- B. Fecal coliform bacteria
- C. Bacterial concentrations
- D. None of the above

### Expected Impact of Pollution

314. The primary sources of \_\_\_\_\_ to fresh water are wastewater treatment plant discharges, failing septic systems, and animal waste.

- A. Bacteria levels
- B. New sources of bacteria
- C. Fecal coliform bacteria
- D. None of the above

315. Bacteria levels do not necessarily decrease as a watershed develops from rural to urban. Instead, urbanization usually generates?

- A. Bacteria levels
- B. New sources of bacteria
- C. Fecal coliform bacteria concentrations
- D. None of the above

316. Farm animal manure and septic systems are replaced by domestic pets and leaking sanitary sewers. In fact, stormwater runoff in urbanized areas has been found to be surprisingly high in?

- A. Bacteria levels
- B. New sources of bacteria
- C. Fecal coliform bacteria concentrations
- D. None of the above

### Indicator Connection Varies

317. General coliforms, E. Coli, and Enterococcus bacteria are the " \_\_\_\_\_ " organisms generally measured to assess microbiological quality of water.

- A. Pathogens
- B. Fecal coliforms
- C. Indicator
- D. None of the above

### E. coli O157:H7

318. Symptoms of E. coli O157:H7 (bacterium) vary with type caused \_\_\_\_\_.

- A. Gastroenteritis
- B. Bacterium
- C. E. coli
- D. None of the above

319. Which of the following is an emerging cause of foodborne illness?

- A. Shigella dysenteriae
- B. Most illnesses
- C. E. coli O157:H7
- D. None of the above

320. Which of the following have been associated with eating undercooked, contaminated ground beef?

- A. Shigella dysenteriae
- B. Most illnesses
- C. E. coli O157:H7
- D. None of the above

321. Which term is used to express that in families and childcare centers are an important mode of transmission and that infection can also occur after drinking raw milk and after swimming in or drinking sewage-contaminated water?

- A. Preventive measures
- B. Person-to-person contact
- C. A cause of illness
- D. None of the above

322. Consumers can prevent \_\_\_\_\_ infection by thoroughly cooking ground beef, avoiding unpasteurized milk, and washing hands carefully.

- A. Shigella dysenteriae
- B. Some illness
- C. E. coli O157:H7
- D. None of the above

### What is Escherichia coli O157:H7?

323. Systems serving 25 to 1,000 people typically take one sample per month. Some states reduce this frequency to quarterly for ground water systems if a recent sanitary survey shows that the system is free of sanitary defects.

- A. True
- B. False

324. Larger types of systems can qualify for five samples a month.

- A. True
- B. False

325. Systems using surface water, rather than ground water, are required to take extra steps to protect against bacterial contamination because surface water sources are more vulnerable to such contamination.

- A. True      B. False

326. Which of the following is a normal occupant of the intestines of all animals, including humans?

- A. *Shigella dysenteriae*      C. Bacterium  
B. *E. coli* O157:H7      D. None of the above

327. Under the Safe Drinking Water Act, the EPA requires public water systems to monitor for?

- A. Indicators      C. Coliform bacteria  
B. Five samples a month      D. None of the above

328. Systems analyze first for total coliform, any time that a sample is positive for total coliform, the same sample must be analyzed for either \_\_\_\_\_.

- A. Total coliform      C. Fecal coliform or *E. coli*  
B. Sanitary survey      D. None of the above

329. Smaller systems must take at least five samples a month unless the state has conducted a sanitary survey – a survey in which a state inspector examines system components and ensures they will protect public health – at the system within the last five years.

- A. True      B. False

330. *E. coli* O157:H7 is one of hundreds of strains of the *Enterococcus* bacteria.

- A. True      B. False

331. *E. coli* O157:H7 was first recognized as a cause of illness in 1982 during an outbreak of severe bloody diarrhea; the outbreak was traced to contaminated hamburgers. Since then, most infections have come from eating undercooked ground beef.

- A. True      B. False

332. The combination of letters and numbers in the name of the bacterium refers to the specific markers found on its surface and distinguishes it from other types of *E. coli*.

- A. True      B. False

333. Currently, there are four recognized classes of \_\_\_\_\_ (collectively referred to as the EEC group) that cause gastroenteritis in humans.

- A. Total coliform      C. Fecal coliform or *E. coli*  
B. Enterovirulent *E. coli*      D. None of the above

### How is *E. coli* O157:H7 spread?

334. The \_\_\_\_\_ can be found on a small number of cattle farms and can live in the intestines of healthy cattle. Meat can become contaminated during slaughter, and organisms can be thoroughly mixed into beef when it is ground.

- A. Organism(s)      C. Hemorrhagic colitis  
B. Bacteria      D. None of the above

### Giardiasis *Giardia lamblia* Section

335. According to the text, *Giardia lamblia* (*intestinalis*) is a single celled animal, i.e., a protozoa, that moves with the aid of five flagella. In Europe, it is sometimes referred to as?

- A. *Lambia intestinalis*      C. *Lamblia intestinalis*  
B. *Giardia intestinalis*      D. None of the above

336. Giardiasis is the most frequent cause of non-bacterial diarrhea in North America. Giardia duodenalis, cause of giardiasis, is a one-celled, Microscopic parasite that can live in the intestines of animals and people.

- A. True      B. False

337. Giardia is found in every region throughout the world and has become recognized as one of the most common causes of waterborne (and occasionally foodborne) illness often referred to as "Beaver Fever."

- A. True      B. False

338. Approximately one week after ingestion of the \_\_\_\_\_, prolonged, greasy diarrhea, gas, stomach cramps, fatigue, and weight loss begin.

- A. Intestinal flora      C. Degrees of symptoms  
B. Giardia cysts      D. None of the above

339. Giardiasis disease runs its course in a week or two, although in some cases, the disease may linger for months, causing severe illness and weight loss. Nonetheless, the basic biology of this \_\_\_\_\_--including how it ravages the digestive tract--is poorly understood.

- A. Intestinal flora      C. Parasite  
B. Giardia cysts      D. None of the above

340. Which of the following uses these mitosomes in the maturation of iron-sulfur proteins rather than in ATP synthesis as is the case in mitochondria-possessing eukaryotes?

- A. Intestinal flora      C. Microaerophilic Giardia  
B. Giardia cysts      D. None of the above

### **Nature of Disease**

341. Which of the following may involve diarrhea within 1 week of ingestion of the cyst, which is the environmental survival form and infective stage of the organism?

- A. Human giardiasis      C. Immune deficiencies  
B. The disease mechanism      D. None of the above

342. Chronic cases, both those with defined \_\_\_\_\_ and those without, are difficult to treat.

- A. Human giardiasis      C. Immune deficiencies  
B. The disease mechanism      D. None of the above

343. Which of the following is unknown, with some investigators reporting that the organism produces a toxin while others are unable to confirm its existence?

- A. Human giardiasis      C. Immune deficiencies  
B. The disease mechanism      D. None of the above

344. Which of the following of the absorptive surface of the intestine has been proposed as a possible pathogenic mechanism, as has a synergistic relationship with some of the intestinal flora?

- A. Intestinal flora      C. Various degrees of symptoms  
B. Mechanical obstruction      D. None of the above

345. Which of the following have been isolated and described through analysis of their proteins and DNA; type of strain, however, is not consistently associated with disease severity?

- A. Several strains of G. lamblia      C. Human giardiasis  
B. The microaerophilic Giardia      D. None of the above

346. Different individuals show various degrees of symptoms when infected with the same strain, and the symptoms of an individual may vary during the \_\_\_\_\_.

- A. Course of the disease      C. Immune deficiencies  
B. The disease mechanism      D. None of the above

### Diagnosis of Human Illness

347. *Giardia lamblia* is frequently diagnosed by visualizing the organism, either the trophozoite (active reproducing form) or the cyst (the resting stage that is resistant to adverse environmental conditions) in stained preparations or unstained wet mounts with the aid of a microscope.

- A. True      B. False

348. Which of the following terms that detects excretory secretory products of the organism is also available?

- A. Bac-T      C. An enzyme linked immunosorbant assay (ELISA)  
B. Lab array      D. None of the above

### Relative Frequency of Disease

349. Which of the following is more prevalent in children than in adults, possibly because many individuals seem to have a lasting immunity after infection?

- A. Infective cysts      C. Giardiasis  
B. Acute outbreaks      D. None of the above

350. Which of the following terms is implicated in 25% of the cases of gastrointestinal disease and may be present asymptotically, the overall incidence of infection is estimated at 2% of the population.

- A. Infective cysts      C. Giardiasis  
B. Acute outbreaks      D. None of the above

351. Which of the following terms appear to be common with infants and is not usually associated with water but is related to child care and diaper changing hygiene procedures.

- A. Infective cysts      C. Intestinal flora  
B. Acute outbreaks      D. None of the above

352. Which of the following terms in immunodeficient and normal individuals are frequently refractile to drug treatment?

- A. Infective cysts      C. Chronic cases of giardiasis  
B. Giardiasis      D. None of the above

### Target Populations

353. Chronic symptomatic giardiasis is more common in adults than children are.

- A. True      B. False

### Cryptosporidiosis Section

354. Until 1993, when over 400,000 people in Milwaukee became ill with diarrhea after drinking water contaminated with the parasite, few people had heard of *Cryptosporidium parvum*, or the disease it causes, cryptosporidiosis.

- A. True      B. False

355. Transmission is also common from ingestion of food or water contaminated with stool, including water in the recreational water park and swimming pool settings.

- A. True      B. False

356. Symptoms of cryptosporidiosis include, most commonly, watery diarrhea and cramps, sometimes severe. Weight loss, nausea, vomiting, and fever are also possible.

- A. True      B. False

357. The severity of symptoms varies with the degree of underlying immunosuppression, with immunocompetent patients commonly experiencing watery diarrhea for a few days to 4 or more weeks and occasionally having a recurrence of diarrhea after a brief period of recovery.

A. True      B. False

358. Cryptosporidiosis is most particularly a danger for the immunocompromised, especially HIV-positive persons and persons with AIDS. Individuals with CD4 cell counts below 200 are more likely to experience severe complications, including prolonged diarrhea, dehydration, and possible death.

A. True      B. False

359. Persons at increased risk for contracting cryptosporidiosis include child care workers; diaper-aged children who attend child care centers; persons exposed to human feces by sexual contact; and caregivers who might come in direct contact with feces while caring for a person infected with cryptosporidiosis.

A. True      B. False

360. Transmission is by an oral-fecal route, including hand contact with the stool of infected humans or animals or with objects contaminated with stool.

A. True      B. False

### **Cholera -*Vibrio cholerae* Section**

361. Cholera, which is derived from a Greek term meaning "Running to the bathroom," is caused by *Vibrio cholerae* and is the most feared epidemic diarrheal disease because of its severity. Dehydration and death can occur within a matter of minutes of infection.

A. True      B. False

362. In 1883, Louis Pasteur discovered *V. cholerae* during a cholera outbreak in Egypt.

A. True      B. False

363. Cholera has been very common in industrialized nations for the last 100 years.

A. True      B. False

364. Cholera is always life-threatening, it is easily prevented and treated with chloramines.

A. True      B. False

365. In the United States, because of advanced water and sanitation systems, cholera is not a major threat; however, everyone, especially travelers, should be aware of how the disease is transmitted and what can be done to prevent it.

A. True      B. False

366. The *V. cholerae* organism is a comma-shaped, gram-negative aerobic bacillus whose size varies from 1-3 mm in length by 0.5-0.8 mm in diameter. Its antigenic structure consists of a flagellar H antigen and a somatic O antigen.

A. True      B. False

367. The differentiation of the latter allows for separation into pathogenic and nonpathogenic strains. *V. cholerae* O1 or O139 are associated with epidemic cholera. *V. cholerae* O1 has 2 major biotypes: classic and El Tor.

A. True      B. False

368. Currently, El Leche is the predominant cholera pathogen.

A. True      B. False

369. A person may get cholera by drinking water or eating food contaminated with the cholera bacterium. In an epidemic, the source of the contamination is usually the feces of an infected person. The disease can spread rapidly in areas with inadequate treatment of sewage and drinking water.  
A. True      B. False
370. The cholera bacterium may also live in the environment in brackish rivers and coastal waters. Shellfish eaten raw have been a source of cholera, and a few persons in the United States have contracted cholera after eating raw or undercooked shellfish from the Gulf of Mexico. The disease is not likely to spread directly from one person to another; therefore, casual contact with an infected person is not a risk for becoming ill.  
A. True      B. False
371. Cholera (also called Asiatic flu) is a disease of the respiratory tract caused by the *Vibrio cholerae* bacterium. These bacteria are typically ingested by drinking water contaminated by improper sanitation or by eating improperly cooked fish, especially shellfish.  
A. True      B. False
372. About one hundred *Vibrio cholerae* bacteria must be ingested to cause cholera in normally healthy adults, although increased susceptibility may be observed in those with a strong immune system, individuals with increased gastric acidity, or those who are malnourished.  
A. True      B. False
373. *Vibrio cholerae* causes disease by producing a toxin that disables the \_\_\_\_\_ of G proteins which are part of G protein-coupled receptors in intestinal cells. This has the effect that the G proteins are locked in the "on position" binding GTP (normally, the G proteins quickly return to "off" by hydrolyzing GTP to GDP).  
A. GTPase function      C. Bacterium  
B. G proteins      D. None of the above
374. The \_\_\_\_\_ then cause adenylate cyclases to produce large amounts of cyclic AMP (cAMP) which results in the loss of fluid and salts across the lining of the gut.  
A. GTPase function      C. Bacterium  
B. G proteins      D. None of the above
375. The resulting diarrhea allows the \_\_\_\_\_ to spread to other people under unsanitary conditions.  
A. Serotypes      C. Bacterium  
B. Flagellar antigens      D. None of the above
376. \_\_\_\_\_ variation plays an important role in the epidemiology and virulence of cholera. The emergence of the Bengal strain is an example.  
A. Serological strain      C. Phenotype  
B. Antigenic      D. None of the above
377. The \_\_\_\_\_ of *V. cholerae* are shared with many water vibrios and therefore are of no use in distinguishing strains causing epidemic cholera.  
A. Serotypes      C. Bacterium  
B. Flagellar antigens      D. None of the above
378. O antigens, however, do distinguish strains of *V. cholerae* into 139 known \_\_\_\_\_.  
A. Serotypes      C. Bacterium  
B. Flagellar antigens      D. None of the above



379. Almost all strains of *V. cholerae* are \_\_\_\_\_.

- A. Serological strain
- B. Nonvirulent
- C. Phenotype
- D. None of the above

380. Until the emergence of the Bengal strain (which is "non-O1") a single serotype, designated O1, has been responsible for epidemic cholera. However, there are three distinct O1 biotypes, named Ogawa, Inaba and Hikojima, and each biotype may display the "classical" or El Tor

- A. Serological strain
- B. Nonvirulent
- C. Phenotype
- D. None of the above

381. *E. coli* produces a toxin, heat labile toxin (LT) that is very similar to the cholera toxin in structure and mode of action. The DNA that encodes the LT \_\_\_\_\_ is on a plasmid that can be transferred to other *E. coli* strains and probably to other enteric bacteria, as well.

- A. Toxin
- B. Enterotoxins
- C. Adenylate cyclase enzyme
- D. None of the above

382. The genetic information for the toxin in *V. cholerae* is located on the bacterial chromosome. Other bacterial \_\_\_\_\_ related to cholera toxin have been reported in non-group O *Vibrio* strains and a strain of *Salmonella*.

- A. Toxin
- B. Enterotoxins
- C. Adenylate cyclase enzyme
- D. None of the above

## Related Diseases and Associated Illnesses Section

### Amebic Meningoencephalitis PAM Section *Naegleria fowleri*

383. Primary Amebic Meningoencephalitis (PAM) is a common and usually deadly disease caused by infection with the amoeba (a multi-celled organism that maintains the original shape).

- A. True
- B. False

384. Following an incubation period of 2-15 days, there is a relatively sudden start of severe meningitis-like symptoms, which begin with fever and headache. These are rapidly followed by sensitivity to light, nausea, projectile vomiting, stiff neck, and, in many cases, disturbances to taste and smell. Changes in behavior and seizures may also be present. As conditions worsen the patient falls into a coma. Death usually occurs 3-7 days after the onset of symptoms.

- A. True
- B. False

385. The amoeba that causes the infection lives in soil and in freshwater ponds, lakes, rivers, poorly or non-chlorinated pools, discharge or holding basins, and hot springs throughout the world. *Naegleria* thrives in warm, stagnant bodies of fresh water when temperatures are high, usually above 80 degrees.

- A. True
- B. False

386. Although the amoeba is commonly found in the environment, PAM is very rare. In the last 30 years, only a few hundred cases have been reported worldwide.

- A. True
- B. False

387. The amoeba is believed to enter the body through the mouth and travel to the stomach. The disease is easily spread from person to person.

- A. True
- B. False

388. The disease is initially suspected based on patient history. The diagnosis is made through the examination of the fluid in the digestive tract or frequently before death through the examination of digestive lining.

- A. True
- B. False

389. PAM is a mild illness that responds to routine treatments. Aggressive use of some antifungal medications have always been successful. Intensive supportive care is rarely necessary along with the medication.

- A. True      B. False

### Noroviruses Section

390. Noroviruses (genus *Norovirus*, family *Caliciviridae*) are a group of related, single-stranded RNA, nonenveloped viruses that cause acute gastroenteritis in humans. Norovirus was recently approved as the official genus name for the group of viruses provisionally described as “Norwalk-like viruses” (NLV).

- A. True      B. False

391. The symptoms of norovirus illness usually include nausea, vomiting, diarrhea, and some stomach cramping. Sometimes people additionally have a low-grade fever, chills, headache, muscle aches, and a general sense of tiredness. The illness often begins suddenly, and the infected person may feel very sick. The illness is usually brief, with symptoms lasting only about 1 or 2 days. In general, children experience more vomiting than adults. Most people with norovirus illness have both of these symptoms.

- A. True      B. False

392. Persons who are infected with norovirus should not prepare food while they have symptoms and for 3 weeks after they recover from their illness. Food that may have been contaminated by an ill person can be eaten.

- A. True      B. False

393. Illness caused by norovirus infection has several names, including stomach flu – this “stomach flu” is **not** related to the flu (or influenza), which is a respiratory illness caused by influenza virus.

- A. True      B. False

394. Noroviruses are found in the stool or vomit of infected people. People can become infected with the virus in several ways, including eating food or drinking liquids that are contaminated with norovirus; touching surfaces or objects contaminated with norovirus, and then placing their hand in their mouth; having direct contact with another person who is infected and showing symptoms (for example, when caring for someone with illness, or sharing foods or eating utensils with someone who is ill).

- A. True      B. False

395. Persons working in day-care centers or nursing homes should pay special attention to children or residents who have norovirus illness. This virus is very contagious and can spread rapidly throughout such environments.

- A. True      B. False

## Water Laboratory Analysis Section

### pH Testing Section

396. When an atom loses \_\_\_\_\_ and thus has more protons than electrons, the atom is a positively-charged ion or cation.

- A. A proton              C. An electron  
B. Charge                D. None of the above

397. Measurement of pH for aqueous solutions can be done with a glass electrode and a pH meter, or using indicators like strip test paper.

- A. True      B. False

398. In chemistry, pH is a measure of the acidity or basicity of an aqueous solution. Solutions with a pH greater than 7 are said to be acidic and solutions with a pH less than 7 are basic or alkaline.

- A. True      B. False

399. Pure water has a pH very close to?

- A. 7
- B. 7.5
- C. 7.7
- D. None of the above

400. \_\_\_\_\_ are determined using a concentration cell with transference, by measuring the potential difference between a hydrogen electrode and a standard electrode such as the silver chloride electrode.

- A. Primary pH standard values
- B. Alkalinity
- C. pH measurement(s)
- D. None of the above

401. Mathematically, pH is the negative logarithm of the activity of the (solvated) hydronium ion, more often expressed as the measure of the?

- A. Electron concentration
- B. Alkalinity concentration
- C. Hydronium ion concentration
- D. None of the above

402. Which of the following terms for aqueous solutions can be done with a glass electrode and a pH meter, or using indicators?

- A. Primary sampling
- B. Measurement of pH
- C. Determining values
- D. None of the above

403 The pH scale is logarithmic and therefore pH is?

- A. An universal indicator
- B. A dimensionless quantity
- C. An excess of alkaline earth metal concentrations
- D. None of the above

404. Measuring alkalinity is important in determining a stream's ability to neutralize acidic pollution from rainfall or wastewater. It is one of the best measures of the sensitivity of the stream to acid inputs. There can be long-term changes in the \_\_\_\_\_ of rivers and streams in response to human disturbances.

- A. Acid
- B. Alkalinity
- C. pH measurement(s)
- D. None of the above

405. pH is defined as the decimal logarithm of the reciprocal of the \_\_\_\_\_,  $a_{H^+}$ , in a solution.

- A. Hydrogen ion activity
- B. Acid-base behavior
- C. Brønsted–Lowry acid–base theory
- D. None of the above

406. Which of the following terms may be used to measure pH, by making use of the fact that their color changes with pH?

- A. Indicators
- B. Spectrophotometer
- C. A set of non-linear simultaneous equations
- D. None of the above

407. Alkalinity is the name given to the quantitative capacity of an aqueous solution to neutralize an?

- A. Acid
- B. Base
- C. Bond formation
- D. None of the above

408. Which of the following terms of the color of a test solution with a standard color chart provides a means to measure pH accurate to the nearest whole number?

- A. Universal indicator
- B. Colorwheel measurement
- C. Visual comparison
- D. None of the above

409. The pH scale is traceable to a set of standard solutions whose pH is established by US EPA.

- A. True
- B. False

410. The calculation of the pH of a solution containing acids and/or bases is an example of a chemical speciation calculation, that is, a mathematical procedure for calculating the concentrations of all chemical species that are present in the solution. The complexity of the procedure depends on the?
- A. Nature of the solution      C. Alkaline earth metal concentrations  
B. pH      D. None of the above
411. Under normal circumstances this means that the concentration of hydrogen ions in acidic solution can be taken to be equal to the concentration of the acid. The pH is then equal to minus the logarithm of?
- A. The concentration value      C. A set of non-linear simultaneous equations  
B. The pH      D. None of the above
412. Alkalinity of water is its acid-neutralizing capacity. It is the sum of all the titratable bases. The measured value may vary significantly with the?
- A. End-point pH      C. pH measurement(s)  
B. Alkalinity      D. None of the above
413. For strong acids and bases no calculations are necessary except in extreme situations. The pH of a solution containing a weak acid requires the solution of a quadratic equation. The pH of a solution containing a weak base may require the?
- A. Solution of a cubic equation      C. Excess of alkaline earth metal concentrations  
B. Non-linear simultaneous equations      D. None of the above
414. Alkalinity is a measure of this missing term and can be interpreted in terms of specific substances only when the chemical composition of the sample is known.
- A. Universal indicator      C. Excess of alkaline earth metal concentrations  
B. An aggregate property of water      D. None of the above
415. More precise measurements are possible if the color is measured spectrophotometrically, using a?
- A. Universal indicator      C. Set of non-linear simultaneous equations  
B. Colorimeter or spectrophotometer      D. None of the above
416. Because the alkalinity of many surface waters is primarily a function of carbonate, bicarbonate, and hydroxide content, it is taken as an indication of the concentration of these constituents.
- A. True      B. False
417. For strong acids and bases no calculations are necessary except in extreme situations. The pH of a solution containing a weak acid requires?
- A. The concentration value      C. Excess of alkaline concentrations  
B. The solution of a quadratic equation      D. None of the above
418. Alkalinity in excess of which term is significant in determining the suitability of water for irrigation?
- A. 8      C. Alkaline earth metal concentrations  
B. pH of 7      D. None of the above
419. The calculation of the pH of a solution containing acids and/or bases is an example of a \_\_\_\_\_ calculation, that is, a mathematical procedure for calculating the concentrations of all chemical species that are present in the solution
- A. Chemical speciation      C. Visual comparison  
B. Spectrophotometer      D. None of the above

420. Since pH is a logarithmic scale, a difference of one pH unit is equivalent to \_\_\_\_\_ fold difference in hydrogen ion concentration

- A. 1    C. 10
- B. .1    D. None of the above

421. Which of the following terms measurements is used in the interpretation and control of water and wastewater treatment processes?

- A. Acid                            C. Hydrogen bond formation
- B. Alkalinity                    D. None of the above

422. Which of the following terms are compounds that, for practical purposes, are completely dissociated in water.

- A. Strong acids and bases    C. Strong bases and weak acids
- B. Chemical ions in chains    D. None of the above

423. The pH of a solution containing a \_\_\_\_\_ may require the solution of a cubic equation.

- A. Strong acids and bases    C. Weak base
- B. Strong base                    D. None of the above

424. Sodium hydroxide, NaOH, is an example of a?

- A. Weak base                    C. Strong acid
- B. Strong base                    D. None of the above

### **Turbidity Testing Sub-Section**

These QA/QC questions ensure that you have read the questions. These questions may seem to be repeats, but are necessary for your comprehension and evaluation.

425. Turbidity is measured to evaluate the performance of \_\_\_\_\_.

- A. Water treatment plant(s)    C. Colloidal to coarse dispersions
- B. An aesthetic point            D. None of the above

426. Turbidity is caused by wide variety of suspended matter that range in size from colloidal to coarse dispersions, depending upon the \_\_\_\_\_, and ranges from pure inorganic substances to those that are highly organic in nature.

- A. Water treatment plant(s)    C. Degree of turbulence
- B. An aesthetic point            D. None of the above

427. Turbid waters are undesirable from \_\_\_\_\_ of view in drinking water supplies.

- A. Water treatment plant(s)    C. Colloidal to coarse dispersions
- B. An aesthetic point            D. None of the above

### **Surface Water (SW) System Compliance**

428. Sample the \_\_\_\_\_ at the clear well

- A. Individual filter effluent    C. Combined filter turbidity
- B. 95% of samples                D. None of the above

429. 0.34 NTU in \_\_\_\_\_, never to exceed 1.0 NTU spike

- A. Individual filter effluent    C. Combined filter turbidity
- B. 95% of samples                D. None of the above

430. Sample turbidity at each \_\_\_\_\_

- A. Individual filter effluent    C. Combined filter turbidity
- B. 95% of samples                D. None of the above

### Disinfection Key

431. 99.9% or 3 log inactivation of \_\_\_\_\_

- A. Crypto
- B. Enteric viruses
- C. Giardia lamblia cysts
- D. None of the above

432. 99.99% or 4 log inactivation of \_\_\_\_\_

- A. Crypto
- B. Enteric viruses
- C. Giardia lamblia cysts
- D. None of the above

433. 99% or 2 log inactivation of \_\_\_\_\_

- A. Crypto
- B. Enteric viruses
- C. Giardia lamblia cysts
- D. None of the above

434. The chlorine residual leaving the plant must be = or \_\_\_\_\_ mg/L and measurable throughout the system.

- A. > 0.2
- B. ≤ 0.2
- C. < 0.2
- D. None of the above

### Turbidity Key

435. Turbidity is normally measured in mg/L and its size is measured in multimeters.

- A. True
- B. False

436. Turbidity can be particles in the water consisting of finely divided solids, larger than bacteria, visible by the naked eye; ranging in size from 10 to 150mm.

- A. True
- B. False

### Cloudy Water

437. In order to have gravity affect these particles, we must somehow make them larger, somehow have them come together (agglomerate); in other words, somehow make them “stick” together, thereby increasing their size and mass.

- A. True
- B. False

### Method 1623 - Cryptosporidium and Giardia Analysis

438. Special sterilization procedures are needed for equipment used in the collection of samples for?

- A. Total Organisms
- B. Cryptosporidium and Giardia
- C. Indicator bugs
- D. None of the above

439. Washing the equipment free of residual sodium hypochlorite solution with three rinses of filter-sterilized water; do not de-chlorinate the equipment using?

- A. Sodium thiosulfate
- B. Sulfuric acid
- C. Sodium hypochlorite solution
- D. None of the above

440. According to the text, composite the sample in a 10-L cubitainer that is pre-sterilized by the manufacturer. The cubitainer is sent in a cardboard box to laboratory for \_\_\_\_\_ analysis.

- A. Cryptosporidium
- B. Indicator organisms
- C. Cholera, polio, typhoid, hepatitis
- D. None of the above

### Cryptosporidium and Giardia Analysis

441. For Cryptosporidium and Giardia analysis by Method 1623 (U.S. Environmental Protection Agency, 1999c), collect 10 L of streamwater for each protozoan pathogen using standard sampling techniques described in Myers and Sylvester (1997). Special sterilization procedures are needed for equipment used in the collection of samples for Cholera, polio, typhoid, hepatitis. Autoclaving is not effective in neutralizing the epitopes on the surfaces of the oocysts and cysts that will react with the antibodies used for detection.

- A. True
- B. False

442. Submerge the equipment in a vessel containing 12 percent hypochlorite solution for 30 minutes. Wash the equipment free of residual sodium thiosulfate solution with three rinses of filter-sterilized water; do not de-chlorinate the equipment using Dibromochloromethane.

- A. True      B. False

443. Composite the sample in a 10-L cubitainer that is pre-sterilized by the manufacturer. The cubitainer is sent in a cardboard box to laboratory for Cholera, polio, typhoid, hepatitis analysis. The sample does not have to be kept on ice during transport.

- A. True      B. False

### Virions

444. Which of the following is a complete functional virus that has the capacity to infect living tissue?

- A. A virion                                      C. Myovirus bacteriophages  
B. Phage's host range                      D. None of the above

445. If the cell was burst unnaturally, then these virus particles cannot be called virion because they will lack certain proteins that will make them infectious even though the \_\_\_\_\_ is present.

- A. Podoviruses                                  C. Genetic material  
B. Viral genome                                D. None of the above

446. According to the text, biomolecules found in virions: genetic material, \_\_\_\_\_, single or double stranded, nucleoprotein capsid.

- A. Either DNA or RNA                        C. Phage lambda of E. coli  
B. Phage's host range                        D. None of the above

### Laboratory Analysis

#### Sample Procedures

447. Samples need to be kept on ice and shipped to a central laboratory for analysis of coliphage, C. perfringens, Cryptosporidium, Giardia, and enteric viruses by the current analytical methods. The single-agar layer (SAL), direct plating method with induction of streptomycin and ampicillin is recommended for detection of somatic and F-specific coliphage in streamwater samples.

- A. True      B. False

448. In this method, 100-mL sample volumes are mixed with an agar medium, E. coli host culture, chemicals that induce the streptomycin and ampicillin enzymes, and appropriate antibiotics. The mixtures are poured into four 150- x 15-mm plates and incubated at 35°C.

- A. True      B. False

449. Upon infection by coliphage in the water sample, the E. coli host cells are lysed and stable indolyl product that is dark blue is visible within each plaque.

- A. True      B. False

450. Viral plaques are easily identified and enumerated by the distinct blue circle. Because of contamination by naturally occurring bacteria in streamwater samples, antibiotic-resistant host-culture strains, E. coli CN-13 (resistant to nalidixic acid) and E. Coli F-amp (resistant to streptomycin and ampicillin) are used as hosts for somatic and F-specific coliphage, respectively.

- A. True      B. False

451. Large sample volumes, such as 1-L volumes or greater, are recommended for detection of coliphage in ground water.

- A. True      B. False

452. Standard MF techniques are used, and \_\_\_\_\_ are incubated anaerobically for 24 hours at 44.5°C.

- A. Oocyst(s)
- B. The plates
- C. Large sample volumes
- D. None of the above

453. After incubation, the plates are exposed to ammonium hydroxide, and all straw-colored colonies that turn dark pink to magenta are counted as \_\_\_\_\_.

- A. Enteric virus(es)
- B. E. coli host culture)
- C. C. perfringens
- D. None of the above

454. Which type of analyses is done with 100-, 30-, and 10-mL volumes of streamwater? In the case of a high-flow or high-turbidity streamwater sample, lower sample volumes may be plated.

- A. Coliphages
- B. C. perfringens
- C. Large sample volumes
- D. None of the above

455. Method 1623 (U.S. Environmental Protection Agency, 1999c) is recommended for detection of Cryptosporidium oocysts and Giardia cysts in water. The oocysts are concentrated on a capsule filter from a 10-L water sample, eluted from the capsule filter with buffer, and concentrated by centrifugation. Immunomagnetic separation (IMS) is used to separate the oocysts from other particulates in the sample.

- A. True
- B. False

456. In IMS, the \_\_\_\_\_ are magnetized by attachment of magnetic beads conjugated to an antibody and then are separated from sediment and debris by means of a magnet.

- A. Oocyst(s)
- B. C. perfringens
- C. Cryptosporidium oocysts and Giardia cysts
- D. None of the above

457. Fluorescently labeled antibodies and vital dye were used to make the final microscopic identification of?

- A. Enteric virus(es)
- B. Oocyst(s)
- C. Oocysts and cysts
- D. None of the above

458. To prepare samples for RT-PCR and cell culture, \_\_\_\_\_ are eluted from a 1MDS filter with beef extract (pH 9.5), concentrated using celite (pH 4.0), and eluted with sodium phosphate (pH 9.5).

- A. Oocyst(s)
- B. C. perfringens
- C. Attached viruses
- D. None of the above

### QA/QC Activities and Measures

459. QA/QC activities and measures to take to reduce contamination.

Use a sterilization indicator, such as autoclave tape, in preparing Viral plaques and other equipment for collection of microbiological samples to determine whether adequate temperatures and pressures have been attained during autoclaving.

- A. True
- B. False

460. Prepare a separate set of E. coli host cultures for microbiological sampling at each site.

- A. True
- B. False

### Field personnel should do the following:

461. Prepare \_\_\_\_\_, a 50- to 100-mL aliquot of sterile buffered water plated before the sample—for every sample by field personnel for total coliform, E. coli, and enterococci analyses to determine the sterility of equipment and supplies.

- A. Reagent water quality
- B. An environmental sample
- C. An MF equipment blank
- D. None of the above



462. Prepare a \_\_\_\_\_, a 50- to 100-mL aliquot of sterile buffered water plated after the sample— for every fourth sample to measure the effectiveness of the analyst's rinsing technique or presence of incidental contamination of the buffered water.

- A. Equipment blank(s)
- B. MF procedure blank(s)
- C. Sterile working surface
- D. None of the above

463. If contamination from a MF equipment or \_\_\_\_\_ is found, results are suspect and are qualified or not reported.

- A. Procedure blank
- B. An environmental sample
- C. An MF equipment blank
- D. None of the above

464. \_\_\_\_\_ for this type of analyses are different from the MF equipment blanks for bacterial analysis.

- A. Equipment blank(s)
- B. MF procedure blank(s)
- C. Appropriate laboratory equipment
- D. None of the above

465. Which are the same as equipment blanks except that they are generated under actual field conditions?

- A. Reagent water quality
- B. Microbiological sampling
- C. Field blanks
- D. None of the above

### Quality Assurance and Quality Control in the Laboratory

466. According to the text, microbiology laboratories must follow good laboratory practices— cleanliness, safety practices, procedures for \_\_\_\_\_, specifications for reagent water quality—as set forth by American Public Health Association.

- A. Reagent water quality
- B. Microbiological sampling
- C. Media preparation
- D. None of the above

## Disinfection Section

### Chlorine's Appearance and Odor

467. Chlorine is a greenish-yellow gas it will condense to an amber liquid at approximately \_\_\_\_\_ F or at high pressures.

- A. -29.2 degrees
- B. - 100 degrees
- C. 29 degrees
- D. None of the above

468. Prolonged exposures to chlorine gas may result in?

- A. Moisture, steam, and water
- B. Odor thresholds
- C. Olfactory fatigue
- D. None of the above

### Chlorine Gas

#### Pathophysiology

469. As far as chlorine safety and respiratory protection, the intermediate \_\_\_\_\_ of chlorine accounts for its effect on the upper airway and the lower respiratory tract.

- A. Effects of Hydrochloric acid
- B. Vapor from Chlorine gas
- C. Water solubility
- D. None of the above

470. Respiratory exposure to \_\_\_\_\_ may be prolonged because its moderate water solubility may not cause upper airway symptoms for several minutes.

- A. Hydrochloric acid
- B. Chlorine gas
- C. Plasma exudation
- D. None of the above

471. The odor threshold for chlorine gas is approximately?

- A. 0.3-0.5 parts per million (ppm)
- B. 3 parts per million (ppm)
- C. 3-5 parts per million (ppm)
- D. None of the above

### **Mechanism of Activity**

472. Chlorine gas feeds out of the cylinder through a gas regulator. The cylinders are on a scale that operators use to measure the amount used each day. The chains are used to prevent the tanks from falling over.

- A. True      B. False

### **Early Response to Chlorine Gas**

473. If you mix ammonia with chlorine gas, this compound reacts to form\_\_\_\_\_.

- A. Chloramine gas      C. Sulfuric gas  
B. Chlorine gas      D. None of the above

### **Reactivity**

474. Cylinders of chlorine may burst when exposed to elevated temperatures. When there is Chlorine in solution, this forms?

- A. Hydrogen sulfide      C. A corrosive material  
B. Oxomonosilane      D. None of the above

475. What is formed when chlorine is in contact with combustible substances (such as gasoline and petroleum products, hydrocarbons, turpentine, alcohols, acetylene, hydrogen, ammonia, and sulfur), reducing agents, and finely divided metals?

- A. Fires and explosions      C. Moisture, steam, and water  
B. Odor thresholds      D. None of the above

476. Contact between chlorine and arsenic, bismuth, boron, calcium, activated carbon, carbon disulfide, glycerol, hydrazine, iodine, methane, oxomonosilane, potassium, propylene, and silicon should be avoided.

- A. True      B. False

477. Chlorine reacts with hydrogen sulfide and water to form this substance?

- A. Hydrogen sulfide      C. Chlorinates  
B. Hydrochloric acid      D. None of the above

478. According to the text, chlorine is also incompatible with?

- A. Plastic      C. Moisture, steam, and water  
B. Palladium      D. None of the above

### **Flammability**

479. When there is a fire that involves Chlorine, the fire fight should be fought downwind from the minimum distance possible.

- A. True      B. False

480. Keep unnecessary people away; isolate the hazard area and deny entry. For a massive fire in a cargo area, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from the area and let the fire burn. Emergency personnel should stay out of low areas and ventilate closed spaces before entering.

- A. True      B. False

481. The effectiveness of chlorination depends on the \_\_\_\_\_ of the water, the concentration of the chlorine solution added, the time that chlorine is in contact with the organism, and water quality.

- A. Chlorine residual      C. Oxygen  
B. Chlorine demand      D. None of the above



### Types of Residual

492. Which of the following is all chlorine that is available for disinfection?

- A. Chlorine residual
- C. Total chlorine
- B. Chlorine demand
- D. None of the above

### Chlorine Exposure Limits

493. What is OSHA's PEL?

- A. 10 PPM
- C. 1,000 PPM
- B. 1 PPM
- D. None of the above

294. Liquid chlorine is about \_\_\_\_\_ times heavier than water

- A. 1.5
- C. 2.5
- B. 10
- D. None of the above

### Alternate Disinfectants - Chloramine

495. It is recommended that Chloramine be used in conjunction with a stronger disinfectant. It is best utilized as a?

- A. Chloramine
- C. Stable distribution system disinfectant
- B. T10 value disinfectant
- D. None of the above

### Chlorine Dioxide

496. Which term provides good Giardia and virus protection but its use is limited by the restriction on the maximum residual of 0.5 mg/L ClO<sub>2</sub>/chlorite/chlorate allowed in finished water?

- A. Chlorinated byproducts
- C. Ammonia residual(s)
- B. Chlorine dioxide
- D. None of the above

### Ozone

497. Ozone is a very effective disinfectant for both Giardia and viruses

- A. True
- B. False

498. When determining Ozone CT (contact time) values must be determined for the ozone basin alone; an accurate \_\_\_\_\_ must be obtained for the contact chamber, and residual levels.

- A. Residual
- C. Contact time
- B. T10 value
- D. None of the above

499. Ozone does not provide a system residual and should be used as a primary disinfectant only in conjunction with?

- A. Dry sodium chlorite
- C. Free and/or combined chlorine
- B. Chlorine dioxide
- D. None of the above

500. Ozone does not produce chlorinated byproducts (such as trihalomethanes) but it may cause an increase in such byproduct formation if it is fed ahead of free chlorine; ozone may also produce its own oxygenated byproducts such as Cl<sub>2</sub> + NH<sub>4</sub>.

- A. True
- B. False