

**Registration form**

**Disinfection Basics CEU Training Course \$200.00  
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*

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

Address: \_\_\_\_\_

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

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

Operator ID# \_\_\_\_\_ Exp Date \_\_\_\_\_

**Please circle/check which certification you are applying the course CEU's.**

Water Treatment \_\_\_\_\_ Distribution \_\_\_\_\_ Collection \_\_\_\_\_

Wastewater Treatment \_\_\_\_\_ Other \_\_\_\_\_

*Your certificate will be mailed to you in about two weeks.*

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Purchase Order #, Please invoice me \_\_\_\_\_

***We will stop mailing the certificate of completion we need your e-mail address. We will e-mail the certificate to you, if no e-mail address; we will mail 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 caused by this CEU education training course material. 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.tlch2o.com/PDF/CEU%20State%20Approvals.pdf>

*You can obtain a printed version of the course from TLC for an additional \$79.95 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.

# Disinfection Basics CEU Course Answer Key

Name \_\_\_\_\_

Telephone # \_\_\_\_\_

*Please select one answer. You can circle, underline, bold or X the answer.*

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

**DISINFECTION BASICS CEU TRAINING 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.**

1. Please rate the difficulty of your course.  
Very Easy   0   1   2   3   4   5   Very Difficult
2. Please rate the difficulty of the testing process.  
Very Easy   0   1   2   3   4   5   Very Difficult
3. Please rate the subject matter on the exam to your actual field or work.  
Very Similar   0   1   2   3   4   5   Very Different
4. How did you hear about this Course? \_\_\_\_\_
5. What would you do to improve the Course?

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How about the price of the course? Poor \_\_\_ Fair\_\_\_ Average\_\_\_ Good \_\_\_ Great \_\_\_

How was your customer service? Poor \_\_\_ Fair\_\_\_ Average\_\_\_ Good \_\_\_ Great \_\_\_

Any other concerns or comments.

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## Disinfection Basics Course Assignment

***The Disinfection Basics CEU 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 in order to receive your Professional Development Hours (PDHs) or Continuing Education Unit (CEU). A score of 70 % is necessary to pass this course. If you should need any assistance, please utilize the search function in Adobe Acrobat.

**We would prefer that you utilize the enclosed answer sheet in the front of this manual, but if you are unable to do so, type out your own answer key. Please include your name and address on your manual and make copy for yourself.**

**There are no intentional trick questions. It is essential to exactly identify the correct answer.**

### Waterborne Pathogens Chapter 1 Assignment

1. Bacteria, viruses and protozoan\_\_\_\_\_. Most pathogens are generally associated with diseases that cause intestinal illness and affect people in a relatively short amount of time, generally a few days to two weeks. They can cause illness through exposure to small quantities of contaminated water or food or from direct contact with infected people or animals.

- A. Microscopic particles
- B. Spreading pathogens by the fecal-oral route
- C. Small quantities of contaminated water or food
- D. That cause disease are known as pathogens
- E. None of the Above

### How Diseases are Transmitted.

2. Pathogens may get into water and spread when infected humans or animals pass the bacteria, viruses, and\_\_\_\_\_. For another person to become infected, he or she must take that pathogen in through the mouth.

- A. Stomach flu
- B. Protozoa in their stool
- C. Contaminating water with pathogens
- D. Pathogen in through the mouth
- E. None of the Above

3. Waterborne pathogens are different from other types of pathogens such as the viruses that cause influenza (the flu) or the bacteria that cause tuberculosis. Influenza virus and tuberculosis bacteria are \_\_\_\_\_ that are coughed or sneezed into the air by an infected person.

- A. Microscopic particles
- B. Spreading pathogens by the fecal-oral route
- C. Small quantities of contaminated water or food
- D. Spread by secretions
- E. None of the Above

4. Human or animal wastes in watersheds, failing septic systems, failing sewage treatment plants or cross-connections of water lines with sewage lines provide the potential for \_\_\_\_\_.

- A. Stomach flu
- B. Fecal-oral route
- C. Contaminating water with pathogens
- D. None of the Above

5. Infected children in diapers may get feces on their fingers, then put their fingers in a friend's mouth or handle toys that other children put into their mouths. The general public and some of the medical community usually refer to diarrhea symptoms as "\_\_\_\_\_."

- A. Stomach flu
- B. Fecal-oral route
- C. Contaminating water with pathogens
- D. Pathogen in through the mouth
- E. None of the Above

6. Technically, influenza is an upper respiratory illness and rarely has diarrhea associated with it; therefore, stomach flu is a misleading description for foodborne or waterborne illnesses, yet is accepted by the general public. So the next time you get the \_\_\_\_\_, you may want to think twice about what you've digested within the past few days.

- A. Stomach flu
- B. Fecal-oral route
- C. Contaminating water with pathogens
- D. Pathogen in through the mouth
- E. None of the Above

7. The water may not appear to be contaminated because feces have been broken up, dispersed, and diluted into \_\_\_\_\_. These particles, containing pathogens, may remain in the water and be passed to humans or animals unless adequately treated.

- A. Microscopic particles
- B. Spreading pathogens by the fecal-oral route
- C. Small quantities of contaminated water or food
- D. Spread by secretions
- E. None of the Above

8. Only proper treatment will ensure eliminating the spread of disease. In addition to water, other methods exist for spreading pathogens by the \_\_\_\_\_. The foodborne route is one of the more common methods.

- A. Stomach flu
- B. Fecal-oral route
- C. Contaminating water with pathogens
- D. Pathogen in through the mouth
- E. None of the Above

9. A frequent source is a food handler who does not wash his hands after a bowel movement and then handles food with "unclean" hands. The individual who eats feces-contaminated food may become infected and ill. It is interesting to note the majority of foodborne diseases occur in the home, not restaurants. Day care centers are another common source for spreading pathogens by the \_\_\_\_\_.

- A. Microscopic particles
- B. Spreading pathogens by the fecal-oral route
- C. Small quantities of contaminated water or food
- D. Fecal-oral route
- E. None of the Above

### **Chain of Transmission**

10. Water is contaminated with feces. This contamination may be of human or animal origin. The feces must contain pathogens (disease-causing bacteria, viruses or protozoa); if the human or animal source is \_\_\_\_\_ with a pathogen, no disease will result.

- A. Not infected
- B. Will survive for only a short time
- C. Must occur
- D. None of the Above

11. A susceptible person must drink the water that \_\_\_\_\_; illness (disease) will occur. This chain lists the events that must occur for the transmission of disease via drinking water.

- A. Not infected
- B. Will survive for only a short time
- C. Contains the pathogen
- D. Breaking the chain
- E. None of the Above

12. The pathogens must survive in the water. This depends on the temperature of the water and the length of time the \_\_\_\_\_.

- A. Illness is frequently
- B. Infect people
- C. Pathogens are in the water
- D. Most common diarrhea illness
- E. None of the Above

13. Some pathogens \_\_\_\_\_, others, such as Giardia or Cryptosporidium may survive for months.

- A. Not infected
- B. Will survive for only a short time
- C. Must occur
- D. Breaking the chain
- E. None of the Above

14. The pathogens in the water must enter the water system's intake, in numbers sufficient to \_\_\_\_\_. The water is either not treated or inadequately treated for the pathogens present.

- A. Illness is frequently
- B. Infect people
- C. Pathogens are in the water
- D. Most common diarrhea illness
- E. None of the Above

15. By \_\_\_\_\_ at any point, the transmission of disease will be prevented.

- A. Not infected
- B. Will survive for only a short time
- C. Must occur
- D. Breaking the chain
- E. None of the Above

### **Bacterial Diseases**

16. Cholera, Legionellosis, Salmonellosis, Shigellosis, and \_\_\_\_\_, 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. Organisms
- B. Aseptic meningitis, polio, and viral gastroenteritis (Norwalk agent)
- C. Disease
- D. Yersiniosis
- E. None of the Above

17. Campylobacteriosis is the \_\_\_\_\_ caused by bacteria. Other symptoms include abdominal pain, malaise, fever, nausea and vomiting.

- A. Illness is frequently
- B. Infect people
- C. Pathogens are in the water
- D. Most common diarrhea illness
- E. None of the Above

18. Symptoms begin three to five days after exposure. The \_\_\_\_\_ over within two to five days and usually lasts no more than 10 days.

- A. Illness is frequently
- B. Infect people
- C. Pathogens are in the water
- D. Most common diarrhea illness
- E. None of the Above

19. \_\_\_\_\_ outbreaks have most often been associated with food, especially chicken and unpasteurized milk, as well as unchlorinated water.

- A. Organisms
- B. Aseptic meningitis, polio, and viral gastroenteritis (Norwalk agent)
- C. Campylobacteriosis
- D. Cholera, Legionellosis, Salmonellosis, Shigellosis, and Yersiniosis
- E. None of the Above

20. These organisms are also an important cause of "travelers' diarrhea." Medical treatment generally is not prescribed for \_\_\_\_\_ because recovery is usually rapid.

- A. Campylobacteriosis
- B. Common viral disease
- C. Some parasites
- D. Hepatitis A
- E. None of the Above

#### **Viral-Caused Diseases**

21. \_\_\_\_\_ is an example of a common viral disease that may be transmitted through water. The onset is usually abrupt, with fever, malaise, loss of appetite, nausea and abdominal discomfort followed within a few days by jaundice.

- A. Campylobacteriosis
- B. Common viral disease
- C. Some parasites
- D. Hepatitis A
- E. None of the Above

22. The \_\_\_\_\_ varies in severity from a mild illness lasting one to two weeks to a severely disabling disease lasting several months (rare). The incubation period is 15-50 days and averages 28-30 days.

- A. Organisms
- B. Aseptic meningitis, polio, and viral gastroenteritis (Norwalk agent)
- C. Disease
- D. Cholera, Legionellosis, Salmonellosis, Shigellosis, and Yersiniosis
- E. None of the Above

23. \_\_\_\_\_ outbreaks have been related to fecally contaminated water; food contaminated by infected food handlers, including sandwiches and salads that are not cooked or are handled after cooking, and raw or undercooked mollusks harvested from contaminated waters.

- A. Campylobacteriosis
- B. Common viral disease
- C. Some parasites
- D. Hepatitis A
- E. None of the Above

24. Aseptic meningitis, polio, and viral gastroenteritis (\_\_\_\_\_) are other viral diseases that can be transmitted through water. Most viruses in drinking water can be inactivated by chlorine or other disinfectants.
- A. Organisms
  - B. Norwalk agent
  - C. Disease
  - D. Cholera, Legionellosis, Salmonellosis, Shigellosis, and Yersiniosis
  - E. None of the Above

#### **Protozoan Caused Diseases**

25. \_\_\_\_\_ are larger than bacteria and viruses, but still microscopic. They invade and inhabit the gastrointestinal tract. Some parasites enter the environment in a dormant form, with a protective cell wall called a "cyst."
- A. Protozoan pathogens
  - B. Common viral disease
  - C. Some parasites
  - D. Hepatitis A
  - E. None of the Above
26. The cyst can survive in the environment for long periods of time and be extremely resistant to conventional disinfectants such as chlorine. Effective filtration treatment is therefore critical to removing these \_\_\_\_\_ from water sources.
- A. Organisms
  - B. Aseptic meningitis, polio, and viral gastroenteritis (Norwalk agent)
  - C. Disease
  - D. Cholera, Legionellosis, Salmonellosis, Shigellosis, and Yersiniosis
  - E. None of the Above
27. Giardiasis is a commonly reported protozoan-caused disease. It has also been referred to as \_\_\_\_\_ because of the many cases reported among hikers and others who consume untreated surface water.
- A. "Backpacker's disease" and "beaver fever"
  - B. Aseptic meningitis, polio, and viral gastroenteritis (Norwalk agent)
  - C. Giardiasis
  - D. Cholera, Legionellosis, Salmonellosis, Shigellosis, and Yersiniosis
  - E. None of the Above
28. Symptoms include chronic diarrhea, abdominal cramps, bloating, frequent loose and pale greasy stools, fatigue and weight loss. The \_\_\_\_\_ is 5-25 days or longer, with an average of 7-10 days.
- A. Same mode of transmission
  - B. Incubation period
  - C. Community-wide outbreaks of disease
  - D. Cramping abdominal pain
  - E. None of the Above
29. Many \_\_\_\_\_ (no symptoms). Giardiasis occurs worldwide. Waterborne outbreaks in the United States occur most often in communities receiving their drinking water from streams or rivers without adequate disinfection or a filtration system.
- A. Self-limiting disease
  - B. No specific treatment
  - C. Recently recognized as causing human disease
  - D. Infections are asymptomatic
  - E. None of the Above

30. The organism, *Giardia lamblia*, has been responsible for more \_\_\_\_\_ in the U.S. than any other pathogen. Drugs are available for treatment, but these are not 100% effective.
- A. Same mode of transmission
  - B. Incubation period
  - C. Community-wide outbreaks of disease
  - D. Cramping abdominal pain
  - E. None of the Above

### **Cryptosporidiosis**

31. Cryptosporidiosis is an example of a \_\_\_\_\_ that is common worldwide, but was only recently recognized as causing human disease. The major symptom in humans is diarrhea, which may be profuse and watery.
- A. Self-limiting disease
  - B. No specific treatment
  - C. Recently recognized as causing human disease
  - D. Protozoan disease
  - E. None of the Above
32. Although most pathogens cause mild, \_\_\_\_\_, on occasion, they can cause serious, even life threatening illness. Particularly vulnerable are persons with weak immune systems, such as those with HIV infections or cancer.
- A. Self-limiting disease
  - B. No specific treatment
  - C. Recently recognized as causing human disease
  - D. Infections are asymptomatic
  - E. None of the Above
33. The diarrhea is associated with \_\_\_\_\_. General malaise, fever, anorexia, nausea, and vomiting occur less often. Symptoms usually come and go, and end in fewer than 30 days in most cases. The incubation period is 1-12 days, with an average of about seven days.
- A. Same mode of transmission
  - B. Incubation period
  - C. Community-wide outbreaks of disease
  - D. Cramping abdominal pain
  - E. None of the Above
34. *Cryptosporidium* organisms have been identified in human fecal specimens from more than 50 countries on six continents. The mode of transmission is fecal-oral, either by person-to-person or animal-to-person. There is \_\_\_\_\_ for *Cryptosporidium* infections.
- A. Self-limiting disease
  - B. No specific treatment
  - C. Recently recognized as causing human disease
  - D. Infections are asymptomatic
  - E. None of the Above
35. All these diseases, with the exception of hepatitis A, 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, and the same routes of transmission, being either \_\_\_\_\_.
- A. Same mode of transmission
  - B. Incubation period
  - C. Community-wide outbreaks of disease
  - D. Foodborne or waterborne
  - E. None of the Above

36. By understanding the \_\_\_\_\_, the importance of properly constructed, operated and maintained public water systems becomes obvious. While water treatment cannot achieve sterile water (no microorganisms), the goal of treatment must clearly be to produce drinking water that is as pathogen-free as possible at all times.

- A. Self-limiting disease
- B. Nature of waterborne diseases
- C. Recently recognized as causing human disease
- D. Infections are asymptomatic
- E. None of the Above

37. For those who operate water systems with inadequate source protection or treatment facilities, the potential risk of a \_\_\_\_\_. For those operating systems that currently provide adequate source protection and treatment, operating and maintaining the system at a high level on a continuing basis is critical to prevent disease.

- A. Same mode of transmission
- B. Incubation period
- C. Community-wide outbreaks of disease
- D. Waterborne disease outbreak is real
- E. None of the Above

### **Bacteriological Monitoring Section Assignment 2**

38. Most waterborne diseases and illnesses have been related to the \_\_\_\_\_ of drinking water.

- A. Sample container
- B. Microbiological quality
- C. Presence of pathogens
- D. Bacteria tests
- E. None of the Above

39. The \_\_\_\_\_ of your water is for coliform bacteria. The coliform bacteria group is used as an indicator organism to determine the biological quality of your water.

- A. Sterilize
- B. Routine microbiological analysis
- C. Relatively simple bacteriological media
- D. Refrigerate the sample
- E. None of the Above

40. The \_\_\_\_\_ in your drinking water is an important health concern.

- A. Touch or contaminate
- B. Indicators
- C. Presence of an indicator or pathogenic bacteria
- D. Iron bacteria
- E. None of the Above

41. Indicator bacteria signal possible \_\_\_\_\_ and therefore, the potential presence of pathogens. They are used to monitor for pathogens because of the difficulties in determining the presence of specific disease-causing microorganisms.

- A. Sample container
- B. Microbiological quality
- C. Presence of pathogens
- D. Fecal contamination
- E. None of the Above

42. Indicator bacteria are usually harmless, occur in high densities in their natural environment and are easily cultured in \_\_\_\_\_.

- A. Sterilize
- B. Routine microbiological analysis
- C. Relatively simple bacteriological media
- D. Refrigerate the sample
- E. None of the Above

43. \_\_\_\_\_ in common use today for routine monitoring of drinking water include total coliforms, fecal coliforms and Escherichia coli (E. coli).

- A. Touch or contaminate
- B. Indicators
- C. Presence of an indicator or pathogenic bacteria
- D. Iron bacteria
- E. None of the Above

### **Bacteria Sampling**

44. \_\_\_\_\_ for bacteria tests must always be collected in a sterile container. Take the sample from an inside faucet with the aerator removed.

- A. Sample container
- B. Microbiological quality
- C. Presence of pathogens
- D. Water samples
- E. None of the Above

45. \_\_\_\_\_ by spraying a 5% household bleach or alcohol solution or flaming the end of the tap with propane torch.

- A. Sterilize
- B. Routine microbiological analysis
- C. Relatively simple bacteriological media
- D. Refrigerate the sample
- E. None of the Above

46. Run the water for five minutes to clear the water lines and bring in fresh water. Do \_\_\_\_\_ the inside of the bottle or cap.

- A. Touch or contaminate
- B. Not touch or contaminate
- C. Presence of an indicator or pathogenic bacteria
- D. Iron bacteria
- E. None of the Above

47. Carefully open the \_\_\_\_\_ and hold the outside of the cap. Fill the container and replace the top.

- A. Sample container
- B. Microbiological bottle
- C. Presence of pathogen test kit
- D. Bacteria test bottle
- E. None of the Above

48. Refrigerate the sample and transport it to the \_\_\_\_\_ within six hours (in an ice chest).

- A. Testing laboratory
- B. Routine microbiological analysis
- C. Relatively simple bacteriological media
- D. Refrigerate the sample
- E. None of the Above

49. Many labs will not accept \_\_\_\_\_ on Friday so check the lab's schedule. Mailing bacteria samples is not recommended because laboratory analysis results are not as reliable.

- A. Bacteria samples
- B. Routine microbiological analysis
- C. Relatively simple bacteriological media
- D. Refrigerate the sample
- E. None of the Above

50. Iron bacteria forms an obvious slime on the inside of pipes and fixtures. A water test is not needed for identification. Check for a \_\_\_\_\_ inside a toilet tank or where water stands for several days.

- A. Reddish-brown slime
- B. Indicators
- C. Presence of an indicator or pathogenic bacteria
- D. Iron bacteria
- E. None of the Above

51. \_\_\_\_\_ are common in the environment and are generally not harmful. However, the presence of these bacteria in drinking water is 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. Fecal coliforms or E. coli
- B. Contaminated with germs
- C. Coliform present
- D. Coliform Bacteria
- E. None of the Above

### Methods

52. The MMO-MUG test, a product marketed as Colilert is the most common. The sample results will be reported by the laboratories\_\_\_\_\_.

- A. Fecal coliforms or E. coli
- B. Contaminated with germs
- C. Coliform present
- D. As simply coliforms present or absent
- E. None of the Above

53. If \_\_\_\_\_, the laboratory will analyze the sample further to determine if these are fecal coliforms or E. coli and report their presence or absence.

- A. Fecal coliforms or E. coli
- B. Contaminated with germs
- C. Coliforms are present
- D. Monitor for contamination
- E. None of the Above

### Types of Water Samples

It is important to properly identify the type of sample you are collecting. Please indicate in the space provided on the laboratory form the type of sample.

The three (3) types of samples are:

54. Samples collected on a routine basis to monitor for contamination. Collection should be in accordance with an approved sampling plan.

- A. Routine
- B. Repeat
- C. Coliform present
- D. Special
- E. None of the Above

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

- A. Routine
- B. Repeat
- C. Coliform present
- D. Special
- E. None of the Above

56. Samples collected for other reasons. Examples would be a sample collected after repairs to the system and before it is placed back into operation or a sample collected at a wellhead prior to a disinfection injection point.

- A. Routine
- B. Repeat
- C. Coliform present
- D. Special
- E. None of the Above

### **Repeat Sampling**

57. \_\_\_\_\_ sampling replaces the old check sampling with a more comprehensive procedure to try to identify problem areas in the system.

- A. Routine
- B. Repeat
- C. Coliform present
- D. Special
- E. None of the Above

58. Whenever a \_\_\_\_\_ sample is total coliform or fecal coliform present a set of repeat samples must be collected within 24 hours after being notified by the laboratory.

- A. Routine
- B. Repeat
- C. Coliform present
- D. Special
- E. None of the Above

### **The follow-up for repeat sampling is:**

59. If only one \_\_\_\_\_ sample per month or quarter is required, four (4) repeat samples must be collected.

- A. Routine
- B. Repeat
- C. Coliform present
- D. Special
- E. None of the Above

60. For systems collecting two (2) or more \_\_\_\_\_ samples per month, three (3) repeat samples must be collected.

- A. Routine
- B. Repeat
- C. Coliform present
- D. Special
- E. None of the Above

61. If the system has only one service connection, the \_\_\_\_\_ samples must be collected from the same sampling location over a four-day period or on the same day.

- A. Routine
- B. Repeat
- C. Coliform present
- D. Special
- E. None of the Above

62. All \_\_\_\_\_ samples are included in the MCL compliance calculation.

- A. Routine
- B. Repeat
- C. Coliform present
- D. Special
- E. None of the Above

63. If a system which normally collects fewer than five (5) routine samples per month has a coliform present sample, it must collect five (5) \_\_\_\_\_ samples the following month or quarter regardless of whether an MCL violation occurred or if repeat sampling was coliform absent.

- A. Routine
- B. Repeat
- C. Coliform present
- D. Special
- E. None of the Above

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

What do you do when your sample is positive or coliform present?

64. When you are notified of a \_\_\_\_\_ you need to contact either the Drinking Water Program or your local county health department within 24 hours, or by the next business day after the results are reported to you. The Drinking Water Program contracts with many of the local health departments to provide assistance to water systems.

- A. Identify all connections
- B. Review your operation
- C. Local health departments
- D. Positive test result
- E. None of the Above

65. 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. Repeat sampling immediately
- B. Possible corrective measures
- C. Routine distribution line flushing
- D. Current construction standards
- E. None of the Above

#### **Some examples of typical corrective measures to coliform problems are:**

66. \_\_\_\_\_ of a ground water well. The recommended dose of 5% household bleach is 2 cups per 100 gallons of water in the well. This should be done anytime the bell is opened for repair (pump replacement, etc.). If you plan to shock the entire system, calculate the total gallonage of storage and distribution.

- A. Identify all connections
- B. Review your operation
- C. Shock chlorination
- D. Plan to shock the entire system
- E. None of the Above

67. Conduct \_\_\_\_\_. Install blowoffs on all dead end lines.
- Being met
  - Possible corrective measures
  - Routine distribution line flushing
  - Current construction standards
  - None of the Above
68. Conduct a \_\_\_\_\_ to identify all connections with non-potable water sources. Eliminate all of these connections or provide approved backflow prevention devices.
- Identify all connections
  - Review your operation
  - Local health departments
  - Cross connection program
  - None of the Above
69. Upgrade the wellhead area to meet \_\_\_\_\_ as set by your state environmental or health agency.
- Being met
  - Possible corrective measures
  - Routine distribution line flushing
  - Current construction standards
  - None of the Above
70. If you \_\_\_\_\_, review your operation and be sure to maintain a detectable residual (0.2 mg/l free chlorine) at all times in the distribution system.
- Identify all connections
  - Review your operation
  - Continuously chlorinate
  - Plan to shock the entire system
  - None of the Above

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

71. State and federal laws establish standards for drinking water quality. Under normal circumstances when \_\_\_\_\_, the water is safe to drink with no threat to human health.
- Being met
  - Possible corrective measures
  - Routine distribution line flushing
  - These standards are being met
  - None of the Above
72. These standards are known as maximum contaminant levels (MCL). When a particular contaminant exceeds its MCL \_\_\_\_\_.
- Potential health threat
  - A potential health threat may occur
  - Confirmed presence
  - Method
  - None of the Above
73. 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 \_\_\_\_\_.
- Published descriptions
  - Compliance
  - Compliance with the MCL
  - Standard plate count
  - None of the Above

**There are two types of MCL violations for coliform bacteria.**

74. The first is for total coliform; the second is an acute risk to health violation characterized by the\_\_\_\_\_.

- A. Potential health threat
- B. Confirmed presence of fecal coliform or E.coli
- C. Confirmed presence
- D. Method
- E. None of the Above

**Heterotrophic Plate Count**

75. Heterotrophic Plate Count (HPC) --- formerly known as the standard plate count, 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. Colonies may arise from pairs, chains, clusters, or single cells, all of which are included in the term "\_\_\_\_\_ " (CFU).

- A. Colony-forming units
- B. Compliance
- C. Heterotrophic Plate Count
- D. Standard plate count
- E. None of the Above

**Methods**

**There are three methods for standard plate count:**

**Pour Plate Method**

76. The colonies produced are relatively small and compact, showing less tendency to encroach on each other than those produced by surface growth. On the other hand, submerged colonies often\_\_\_\_\_.

- A. Potential health threat
- B. Difficult to transfer
- C. Confirmed presence
- D. Are slower growing and are difficult to transfer
- E. None of the Above

**Spread Plate Method**

77. All colonies are on the agar surface where they can be distinguished readily from particles and bubbles. Colonies can be\_\_\_\_\_, and colony morphology easily can be discerned and compared to published descriptions.

- A. Transferred quickly
- B. Compliance
- C. Heterotrophic Plate Count
- D. Standard plate count
- E. None of the Above

**Membrane Filter Method**

78. This \_\_\_\_\_permits testing large volumes of low-turbidity water and is the method of choice for low-count waters.

- A. Potential health threat
- B. Difficult to transfer
- C. Confirmed presence
- D. Method
- E. None of the Above

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

79. Heterotrophic organisms utilize organic compounds as their carbon source (food or substrate). In contrast, autotrophic organisms use inorganic carbon sources. The \_\_\_\_\_ provides a technique to quantify the bacteriological activity of a sample.

- A. Published descriptions
- B. Compliance
- C. Heterotrophic Plate Count
- D. Standard plate count
- E. None of the Above

80. The R2A agar provides a medium that will support a large variety of heterotrophic bacteria. After \_\_\_\_\_, a bacteriological colony count provides an estimate of the concentration of heterotrophs in the sample of interest.

- A. Routine analysis
- B. Bacteriological colony count
- C. Sample volume
- D. An incubation period
- E. None of the Above

**Counting and Recording**

81. After incubation period, promptly count all colonies on the plates. To count, uncover plate and place on Quebec colony counter. Use hand tally counter to maintain count. \_\_\_\_\_, regardless of size.

- A. Acute health risk violation
- B. E. coli present
- C. Count all colonies on the plate
- D. Quebec colony counter
- E. None of the Above

82. To report counts on a plate with no colonies, report the count as less than one (<1) divided by the \_\_\_\_\_ put on that plate (remember to account for any dilution of that sample).

- A. Routine analysis
- B. Bacteriological colony count
- C. Sample volume
- D. State drinking water section
- E. None of the Above

**Total Coliforms**

83. This MCL is based on the presence of total coliforms, and compliance is on a monthly or quarterly basis, depending on your water system type and state rule. For systems which collect fewer than 40 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 an MCL violation.

- A. Acute health risk violation
- B. 4 samples per month
- C. 40 samples per month
- D. 400 samples per month
- E. None of the Above

84. For systems which collect 40 or more samples per month, no more than five (5) percent may be \_\_\_\_\_, check with your state drinking water section or health department for further instructions.

- A. Routine analysis
- B. Bacteriological colony count
- C. Positive
- D. None of the Above

**Acute Risk to Health (Fecal Coliforms and E. Coli)**

85. An acute risk to human health violation occurs if either one of the following happens:

A \_\_\_\_\_ shows total coliform present and is followed by a repeat analysis which indicates fecal coliform or E. coli present.

- A. Acute health risk violation
- B. E. coli present
- C. Routine analysis
- D. Quebec colony counter
- E. None of the Above

86. A \_\_\_\_\_ shows total and fecal coliform or E. coli present and is followed by a repeat analysis which indicates total coliform present.

- A. Routine analysis
- B. Bacteriological colony count
- C. Sample volume
- D. State drinking water section
- E. None of the Above

87. An \_\_\_\_\_ requires the water system to provide public notice via radio and television stations in the area.

- A. Acute health risk violation
- B. E. coli present
- C. 40 samples per month
- D. Quebec colony counter
- E. None of the Above

88. This type of contamination can pose an immediate threat to human health and notice must be given as soon as possible, but no later than 72 hours \_\_\_\_\_ from your laboratory of the test results.

- A. An applicable MCL or treatment technique
- B. An immediate threat
- C. And contain certain mandatory language
- D. After notification
- E. None of the Above

89. Certain language may be mandatory for \_\_\_\_\_ and is included in your state drinking water rule.

- A. Testing procedure
- B. Violations
- C. An acute risk
- D. Both these violations
- E. None of the Above

**Public Notice**

90. A public notice is required to be issued by a water system whenever it fails to comply with \_\_\_\_\_, or fails to comply with the requirements of any scheduled variance or permit. This will inform users when there is a problem with the system and give them information.

- A. An applicable MCL or treatment technique
- B. An immediate threat
- C. And contain certain mandatory language
- D. Quebec colony counter
- E. None of the Above

91. A public notice is also required whenever a water system fails to comply with its \_\_\_\_\_ or testing procedure.

- A. Testing procedure
- B. Violations
- C. An acute risk
- D. Monitoring and/or reporting requirements
- E. None of the Above

92. Each public notice must contain certain information, be issued properly and in a \_\_\_\_\_, and contain certain mandatory language.

- A. An applicable MCL or treatment technique
- B. An immediate threat
- C. And contain certain mandatory language
- D. Timely manner
- E. None of the Above

93. The timing and place of posting of the public notice depends on whether an acute risk is present to users. Check with your state drinking water section or health department for \_\_\_\_\_.

- A. Testing procedure
- B. Violations
- C. An acute risk
- D. Further instructions
- E. None of the Above

### **Legionella Section Review Assignment Part 3**

94. The first discovery of bacteria from genus Legionella came in 1976 when an outbreak of \_\_\_\_\_ at an American Legion convention led to 29 deaths.

- A. Legionnaires' disease
- B. Pneumonia
- C. Pontiac fever
- D. Legionella pneumophila
- E. None of the above

95. The causative agent, what would come to be known as \_\_\_\_\_, was isolated and given its own genus.

- A. Legionnaires' disease
- B. Pneumonia
- C. Pontiac fever
- D. Legionella pneumophila
- E. None of the above

96. The organisms classified in this genus are Gram-negative bacteria that are considered \_\_\_\_\_.

- A. Legionnaires' disease
- B. Pneumonia
- C. Pontiac fever
- D. Intracellular parasites
- E. None of the above

97. Legionnaires' disease is the more severe form of infection which includes pneumonia; \_\_\_\_\_ is a milder illness.

- A. Legionnaires' disease
- B. Pneumonia
- C. Pontiac fever
- D. None of the above

98. The major source is water distribution systems of large buildings including hotels and hospitals. Cooling towers have long been thought to be a major source for \_\_\_\_\_, but new data suggest that this is an overemphasized mode of transmission.

- A. Legionnaires' disease
- B. Pneumonia
- C. Pontiac fever
- D. Legionella
- E. None of the above

99. Other sources include mist machines, humidifiers, whirlpool spas, and hot springs. Air conditioners are not a source for \_\_\_\_\_. They were suspected to be the source in the original American Legion outbreak in a Philadelphia hotel, but new data now suggests that the water in the hotel was the actual culprit.

- A. Legionnaires' disease
- B. Pneumonia
- C. Pontiac fever
- D. Legionella pneumophila
- E. None of the above

100. \_\_\_\_\_ is the most common way that bacteria enter into the lungs to cause pneumonia. It means choking such that secretions in the mouth get past the choking reflexes and instead of going into the esophagus and stomach, mistakenly, enter the lung. The protective mechanisms to prevent it is defective in patients who smoke or have lung disease.

- A. Routine maintenance program
- B. Aspiration
- C. Aerosol
- D. Naturally found
- E. Multiply

101. Legionella may \_\_\_\_\_ to high numbers in cooling towers, evaporative condensers, air washers, humidifiers, hot water heaters, spas, fountains, and plumbing fixtures.

- A. Routine maintenance program
- B. Aspiration
- C. Aerosol
- D. Naturally found
- E. Multiply

102. Legionnaire's disease is caused most commonly by the inhalation of small droplets of water or fine \_\_\_\_\_ containing Legionella bacteria.

- A. Routine maintenance program
- B. Aspiration
- C. Aerosol
- D. Naturally found
- E. Multiply

103. Legionella bacteria are \_\_\_\_\_ in environmental water sources such as rivers, lakes and ponds and may colonise man-made water systems that include air conditioning systems, humidifiers, cooling tower waters, hot water systems, spas and pools.

- A. Routine maintenance program
- B. Aspiration
- C. Aerosol
- D. Naturally found
- E. Multiply

104. Within one month, Legionella can \_\_\_\_\_, in warm water-containing systems, from less than 10 per milliliter to over 1,000 per milliliter of water.

- A. Routine maintenance program
- B. Aspiration
- C. Aerosol
- D. Naturally found
- E. Multiply

105. Culture methods will not identify \_\_\_\_\_ legionella that can still cause outbreaks (non-culturable, viable legionella have been reported in several peer-reviewed journals). Only DFA tests performed by trained laboratory personnel can identify these legionella.

- A. Aerobic rods
- B. Non-culturable
- C. Ultraviolet light
- D. Fluorescent
- E. Quantitative monitoring

106. Direct \_\_\_\_\_ antibody (DFA) tests using a battery of monoclonal antibodies provide more useful routine monitoring information than culture methods.

- A. Aerobic rods
- B. Non-culturable
- C. Ultraviolet light
- D. Fluorescent
- E. Quantitative monitoring

107. Legionella species of bacteria cause Legionnaire's disease. They are gram negative (but stain poorly), strictly \_\_\_\_\_.

- A. Aerobic rods
- B. Non-culturable
- C. Ultraviolet light
- D. Fluorescent
- E. Quantitative monitoring

108. Once high numbers of Legionella have been found, a relatively simple procedure for disinfecting water systems with chlorine and detergent is available. This procedure is not part of a \_\_\_\_\_ because equipment may become corroded.

- A. Routine maintenance program
- B. Aspiration
- C. Aerosol
- D. Naturally found
- E. Multiply

109. Currently, there are no United States government regulations concerning \_\_\_\_\_ numbers of legionella in water systems and there are no federal or state certification programs for laboratories that perform legionella testing of environmental samples.

- A. Serogroups
- B. Permissible
- C. Ultraviolet light
- D. Biocide
- E. Quantitative monitoring

110. The epifluorescence microscopy DFA method that most labs use was published in the British Journal, Water Research 19:839-848, 1985 "Disinfection of circulating water systems by \_\_\_\_\_ and halogenation", R. Gilpin, et al. so we can count viable-but-nonculturable

(VBNC) legionella.

- A. Serogroups
- B. Permissible
- C. Ultraviolet light
- D. Biocide
- E. Quantitative monitoring

111. Most labs will provide a \_\_\_\_\_ microscopic analysis of your cooling tower and potable water samples for 14 serogroups of Legionella pneumophila and 15 other Legionella species.

- A. Serogroups
- B. Permissible
- C. Ultraviolet light
- D. Biocide
- E. Quantitative epifluorescence

112. Legionnaires' disease is caused by bacteria that belong to the family \_\_\_\_\_.

- A. Coccobacilli
- B. Legionella genus
- C. Legionellaceae
- D. Serogroups
- E. Legionella pneumophila

113. This family now includes 48 species and over 70 \_\_\_\_\_. Approximately half of these species have been implicated in human disease.

- A. Coccobacilli
- B. Legionella genus
- C. Legionellaceae
- D. Serogroups
- E. Legionella pneumophila

114. \_\_\_\_\_ is responsible for approximately 90% of infections.

- A. Coccobacilli
- B. Legionella genus
- C. Legionellaceae
- D. Serogroups
- E. Legionella pneumophila

## Viruses

### Disinfection Byproduct Section Assignment

115. Disinfection byproducts are formed when disinfectants used in water treatment plants react with \_\_\_\_\_ (i.e., decaying vegetation) present in the source water.

- A. Microbial contaminants
- B. Bromide and/or natural organic matter
- C. Disinfectants
- D. Bromate and chlorite
- E. None of the Above

116. Different \_\_\_\_\_ produce different types or amounts of disinfection byproducts.

- A. Disinfection byproducts
- B. Cryptosporidium
- C. Disinfectants
- D. None of the Above

117. Disinfection byproducts for which regulations have been established have been identified in drinking water, including \_\_\_\_\_, haloacetic acids, bromate and chlorite.

- A. Microbial contaminants
- B. Trihalomethanes
- C. Disinfectants
- D. Bromate and chlorite
- E. None of the Above

118. Trihalomethanes (THM) are a group of four chemicals that are formed along with other disinfection byproducts when \_\_\_\_\_ used to control microbial contaminants in drinking water react with naturally occurring organic and inorganic matter in water.

- A. Disinfection byproducts
- B. Cryptosporidium
- C. Chlorine or other disinfectants
- D. Organic and inorganic matter
- E. None of the Above

119. The \_\_\_\_\_ are chloroform, bromodichloromethane, dibromochloromethane, and bromoform.

- A. Bromate
- B. Trihalomethanes
- C. Organic and inorganic matter
- D. Chlorine dioxide
- E. None of the Above

120. The EPA has published the **Stage 1 Disinfectants/Disinfection Byproducts Rule** to regulate \_\_\_\_\_ at a maximum allowable annual average level of **80 ppb**.

- A. Pathogens
- B. Total trihalomethanes (TTHM)
- C. Giardia
- D. HAA5
- E. None of the Above

121. Haloacetic Acids (HAA5) are a group of chemicals that are formed along with other \_\_\_\_\_ when chlorine or other disinfectants used to control microbial contaminants in drinking water react with naturally occurring organic and inorganic matter in water.

- A. Disinfection byproducts
- B. Trihalomethanes
- C. Organic and inorganic matter
- D. Chlorine dioxide
- E. None of the Above

122. The regulated haloacetic acids, known as \_\_\_\_\_, are monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid and dibromoacetic acid. The EPA has published the **Stage 1 Disinfectants/Disinfection Byproducts Rule** to regulate HAA5 at **60 ppb** annual average.

- A. Pathogens
- B. Bromate
- C. Giardia
- D. HAA5
- E. None of the Above

123. \_\_\_\_\_ is a chemical that is formed when ozone used to disinfect drinking water, reacts with naturally occurring bromide found in source water.

- A. Bromate
- B. Trihalomethanes
- C. Organic and inorganic matter
- D. Chlorine dioxide
- E. None of the Above

124. The EPA has established the **Stage 1 Disinfectants/Disinfection Byproducts Rule** to regulate \_\_\_\_\_ at an annual average of **10 ppb** in drinking water.

- A. Pathogens
- B. Bromate
- C. Giardia
- D. HAA5
- E. None of the Above

125. \_\_\_\_\_ is a byproduct formed when chlorine dioxide is used to disinfect water. The EPA has published the **Stage 1 Disinfectants/Disinfection Byproducts Rule** to regulate chlorite at a monthly average level of **1 ppm** in drinking water.

- A. Bromate
- B. Trihalomethanes
- C. Chlorite
- D. Chlorine dioxide
- E. None of the Above

#### **Microbial Regulations**

126. The **Interim Enhanced Surface Water Treatment Rule** was established in December 1998 to control \_\_\_\_\_, and to maintain control of pathogens while systems lower disinfection byproduct levels to comply with the **Stage 1 Disinfectants/Disinfection Byproducts Rule**.

- A. Turbidity
- B. Pathogens
- C. Giardia
- D. Cryptosporidium
- E. None of the Above

127. The EPA established a Maximum Contaminant Level Goal (MCLG) of zero for all public water systems and a 99 percent removal requirement for \_\_\_\_\_ in filtered public water systems that serve at least 10,000 people.

- A. Pathogens
- B. Coliform bacteria
- C. Disinfectant residual
- D. Cryptosporidium
- E. None of the Above

128. \_\_\_\_\_ is an indicator of the physical removal of particulates, including pathogens.

- A. Turbidity
- B. Pathogens
- C. Giardia
- D. Contaminated with germs which can cause disease
- E. None of the Above

129. The EPA is also planning to develop other rules to further control pathogens. The EPA has promulgated a Long Term 1 Enhanced Surface Water Treatment Rule for systems serving fewer than 10,000 people. This is to improve physical removal of \_\_\_\_\_ and to maintain control of pathogens while systems comply with **Stage 1 Disinfectants/Disinfection Byproducts Rule**.

- A. Pathogens
- B. Coliform bacteria
- C. Disinfectant residual
- D. Cryptosporidium
- E. None of the Above

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

- A. Turbidity
- B. Pathogens
- C. Giardia
- D. Contaminated with germs which can cause disease
- E. None of the Above

131. Among its 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 \_\_\_\_\_ and viruses by at least 99.9% and 99.99%, respectively.

- A. Turbidity
- B. Pathogens
- C. Giardia
- D. Contaminated with germs which can cause disease
- E. None of the Above

132. The Surface Water Treatment Rule specifies treatment criteria to assure that these performance requirements are met; they include \_\_\_\_\_, disinfectant residual and disinfectant contact time conditions.

- A. Pathogens
- B. Turbidity limits
- C. Disinfectant residual
- D. Cryptosporidium
- E. None of the Above

#### **Chlorine Introduction Section Assignment**

133. Today, most of our drinking water supplies are free of the micro-organisms — viruses, bacteria, and protozoa — that cause serious and life-threatening diseases, such as cholera and typhoid fever. This is largely due to the introduction of water treatment, particularly \_\_\_\_\_, at the turn of the century.

- A. Contaminated
- B. Chlorination
- C. Combined chlorine
- D. Break Point Chlorination
- E. None of the Above

134. Living cells react with chlorine and reduce its concentration while they die. The organic matter and other substances that are present, convert to \_\_\_\_\_, some of which are effective killing agents.

- A. Chlorination by-products
- B. Chlorinated organic compounds
- C. Combined chlorine
- D. Chlorinated derivatives
- E. None of the Above

135. Chlorine present as  $\text{Cl}$ ,  $\text{HOCl}$ , and  $\text{OCl}^-$  is called \_\_\_\_\_ and that which is bound but still effective is combined chlorine.

- A. Free available chlorine
- B. Chlorination
- C. Combined chlorine
- D. Break Point Chlorination
- E. None of the Above

136. A particularly important group of compounds with combined chlorine is the \_\_\_\_\_ formed by reactions with ammonia.

- A. Chlorination by-products
- B. Chloramines
- C. Combined chlorine
- D. Chlorinated derivatives
- E. None of the Above

137. One especially important feature of disinfection using \_\_\_\_\_ is the ease of overdosing to create a "residual" concentration. There is a constant danger that safe water leaving the treatment plant may become contaminated later. There may be breaks in water mains, loss of pressure that permits an inward leak, or plumbing errors.

- A. Chlorine
- B. Chlorination
- C. Combined chlorine
- D. Break Point Chlorination
- E. None of the Above

138. This residual concentration of chlorine provides some degree of protection right to the water faucet. With \_\_\_\_\_, a typical residual is from 0.1 to 0.5 ppm. Because chlorinated organic compounds are less effective, a typical residual is 2 ppm for combined chlorine.

- A. Chlorination by-products
- B. Chlorinated organic compounds
- C. Combined chlorine
- D. Free available chlorine
- E. None of the Above

139. There will be no chlorine residual unless there is an excess over the amount that reacts with the organic matter present. However, reaction kinetics complicates interpretation of chlorination data. The correct excess is obtained in a method called "\_\_\_\_\_".

- A. Contaminated
- B. Chlorination
- C. Combined chlorine
- D. Break Point Chlorination
- E. None of the Above

### **Chlorine By-Products**

140. Chlorination by-products are the chemicals formed when the \_\_\_\_\_ used to kill disease-causing micro-organisms reacts with naturally occurring organic matter (e.g., decay products of vegetation) in the water.

- A. Chlorination by-products
- B. Chlorinated organic compounds
- C. Chlorine
- D. Chlorinated derivatives
- E. None of the Above

141. The most common \_\_\_\_\_ by-products found in U.S. drinking water supplies are the trihalomethanes (THMs).

- A. Contaminated
- B. Chlorination
- C. Combined chlorine
- D. Break Point Chlorination
- E. None of the Above

**The Principal Trihalomethanes are:**

142. Chloroform, bromodichloromethane, chlorodibromomethane, and bromoform. Other less common chlorination by-products includes the \_\_\_\_\_ and haloacetonitriles.

- A. THMs
- B. Haloacetonitriles
- C. THM levels
- D. Haloacetic acids
- E. None of the Above

143. The amount of \_\_\_\_\_ formed in drinking water can be influenced by a number of factors, including the season and the source of the water. For example, THM concentrations are generally lower in winter than in summer, because concentrations of natural organic matter are lower and less chlorine is required to disinfect at colder temperatures.

- A. THMs
- B. Haloacetonitriles
- C. THM levels
- D. Chlorine
- E. None of the Above

144. \_\_\_\_\_ are also low when wells or large lakes are used as the drinking water source, because organic matter concentrations are generally low in these sources.

- A. THMs
- B. Haloacetonitriles
- C. THM levels
- D. Chlorine
- E. None of the Above

145. The opposite — high organic matter concentrations and high \_\_\_\_\_ — is true when rivers or other surface waters are used as the source of the drinking water.

- A. THMs
- B. Haloacetonitriles
- C. THM levels
- D. Chlorine
- E. None of the Above

**Health Effects**

146. Laboratory animals exposed to very high levels of \_\_\_\_\_ have shown increased incidences of cancer.

- A. THMs
- B. Haloacetonitriles
- C. THM levels
- D. Chlorine
- E. None of the Above

147. Several studies of cancer incidence in human populations have reported associations between long-term exposure to high levels of \_\_\_\_\_ and an increased risk of certain types of cancer. For instance, a recent study conducted in the Great Lakes basin reported an increased risk of bladder and possibly colon cancer in people who drank chlorinated surface water for 35 years or more.

- A. THMs
- B. Haloacetonitriles
- C. THM levels
- D. Chlorination by-products
- E. None of the Above

148. Possible relationships between exposure to \_\_\_\_\_ and adverse reproductive effects in humans have also been examined recently. In a California study, pregnant women who consumed large amounts of tap water containing elevated levels of THMs were found to have an increased risk of spontaneous abortion.

- A. THMs
- B. Haloacetonitriles
- C. THM levels
- D. High levels of THMs
- E. None of the Above

149. The available studies on health effects do not provide conclusive proof of a relationship between exposure to \_\_\_\_\_ and cancer or reproductive effects, but indicate the need for further research to confirm their results and to assess the potential health effects of chlorination by-products other than THMs.

- A. THMs
- B. Haloacetonitriles
- C. THM levels
- D. Chlorine
- E. None of the Above

#### **Chlorine Disinfectants/Disinfectant By-Products (DBPs)**

150. Ozone is also used to \_\_\_\_\_.

- A. Chloroform
- B. Chlorine disinfection
- C. Ozone
- D. Disinfect water
- E. None of the Above

151. \_\_\_\_\_ are very active compounds. When added to a water supply, disinfectants not only kill bacteria and viruses, but also react with other chemicals present in the water. These chemicals generally enter the water supply through natural plant and soil breakdown.

- A. Disinfectants
- B. DBPs produced
- C. Chlorine and ammonia bonded together
- D. DBPs
- E. None of the Above

152. When disinfectants react with other chemicals, new compounds known as disinfectant by-products or "DBPs", are created. DBPs associated with \_\_\_\_\_ include trihalomethanes (THMs), such as chloroform.

- A. Chloroform
- B. Chlorine disinfection
- C. Ozone
- D. Disinfect water
- E. None of the Above

153. \_\_\_\_\_ is a naturally existing element that has been used to disinfect drinking water supplies in America for most of the 20<sup>th</sup> Century.

- A. THMs
- B. Haloacetonitriles
- C. THM levels
- D. Chlorine
- E. None of the Above

154. \_\_\_\_\_ has been extremely effective in protecting drinking water resources from bacterial and viral contamination. It has virtually wiped out instances of water-borne diseases like typhoid fever, cholera and dysentery in America and other developed countries.

- A. Chloroform
- B. Chlorine disinfection
- C. Ozone
- D. Disinfect water
- E. None of the Above

155. The three primary chemical agents used in \_\_\_\_\_ are: free chlorine, chloramine (chlorine and ammonia bonded together) and chlorine dioxide (chlorine and oxygen bonded together).

- A. Chlorine disinfection
- B. DBPs produced
- C. Chlorine and ammonia bonded together
- D. DBPs
- E. None of the Above

156. Because chlorination has been used for almost 100 years to disinfect water supplies, approximately 40 percent of the \_\_\_\_\_ from chlorination have been identified and researched. Much less is known about the kind of DBPs produced by other disinfectants because of their relatively recent emergence.

- A. Very active compounds
- B. DBPs produced
- C. Chlorine and ammonia bonded together
- D. DBPs
- E. None of the Above

157. Use of \_\_\_\_\_ in chlorine disinfection produces fewer DBPs than chlorine, but each has associated risks. Chloramine is not as strong a disinfectant as chlorine, and disinfection with chlorine dioxide produces its own DBPs.

- A. Chloroform
- B. Chlorine disinfection
- C. Ozone
- D. Chloramine or chlorine dioxide
- E. None of the Above

158. Animal research using high concentration of \_\_\_\_\_ increased occurrence of cancer development, although why this occurs has not yet been determined. Research on the relationship between DBPs and cancer and other health risks is ongoing.

- A. Very active compounds
- B. DBPs found
- C. Chlorine and ammonia bonded together
- D. DBPs
- E. None of the Above

159. American drinking water has very low concentrations of \_\_\_\_\_.

- A. Very active compounds
- B. DBPs produced
- C. Chlorine and ammonia bonded together
- D. DBPs
- E. None of the Above

160. Since 1984, American drinking water utilities have spent almost \$23 million researching the production of DBPs, the risks posed by them and methods to treat them. These research efforts are ongoing. In addition, the 300 largest drinking water utilities have spent more than \$150 million to conduct the information gathering required by the Information Collection Rule (\_\_\_\_\_).

- A. THMs
- B. ICR
- C. Chlorine
- D. DDPB
- E. None of the Above

161. The ICR is the largest study to date pertaining to the occurrence of \_\_\_\_\_ and associated treatment practices.

- A. THMs
- B. ICR
- C. DBPs
- D. DDPB
- E. None of the Above

162. Since 1979, the U.S. Environmental Protection Agency (USEPA), under the authority of the Safe Drinking Water Act, has regulated the acceptable levels of some DBPs. USEPA cites the large population of Americans potentially \_\_\_\_\_ as the impetus for regulation.

- A. Other disinfectants are available
- B. At-risk from low-level DPB exposure
- C. Concentration level exposure
- D. Actual health risks posed by DBPs still remain
- E. None of the Above

163. The Safe Drinking Water Act Amendments of 1996 required USEPA to comply with the regulatory timeline it set forth in its initial Disinfectant and Disinfectant-By-Product (\_\_\_\_\_) rule and Interim Enhanced Surface Water Treatment Rule (IESWTR). USEPA proposed both in 1994.

- A. THMs
- B. ICR
- C. Chlorine
- D. DDPB
- E. None of the Above

164. The U.S. Environmental Protection Agency (USEPA) has not been able to link exposure to DBPs at low concentration levels and the health risks associated with \_\_\_\_\_.

- A. Other disinfectants are available
- B. At-risk from low-level DPB exposure
- C. High concentration level exposure
- D. Actual health risks posed by DBPs still remain
- E. None of the Above

165. The research on DBPs and their impact on public health continues and serious questions about the \_\_\_\_\_.

- A. Other disinfectants are available
- B. At-risk from low-level DPB exposure
- C. Concentration level exposure
- D. Actual health risks posed by DBPs still remain
- E. None of the Above

### **Risks and Benefits of Chlorine**

166. Current evidence indicates that the benefits of chlorinating our drinking water — reduced incidence of water-borne diseases — are much greater than the risks of health effects from \_\_\_\_\_.

- A. THMs
- B. ICR
- C. Chlorine
- D. DDPB
- E. None of the Above

167. Although \_\_\_\_\_, chlorine continues to be the choice of water treatment experts.

- A. Other disinfectants are available
- B. At-risk from low-level DPB exposure
- C. Concentration level exposure
- D. Actual health risks posed by DBPs still remain
- E. None of the Above

168. When used with modern water filtration practices, chlorine is effective against virtually all infective agents — \_\_\_\_\_. It is easy to apply, and, most importantly, small amounts of chlorine remain in the water and continue to disinfect throughout the distribution system.

- A. Bacteria, viruses, and protozoa
- B. ICR
- C. Chlorine
- D. DDPB
- E. None of the Above

169. This ensures that the water remains free of \_\_\_\_\_ on its journey from the treatment plant to the consumer's tap.

- A. Microbial contamination
- B. Other undesirable by-products
- C. Chloramines and chlorine dioxide
- D. Chlorination by-products
- E. None of the Above

170. A number of cities use \_\_\_\_\_ to disinfect their source water and to reduce THM formation.

- A. Ozone
- B. Other undesirable by-products
- C. Chlorine and chlorine dioxide
- D. Chlorination by-products
- E. None of the Above

171. Although \_\_\_\_\_ is a highly effective disinfectant, it breaks down quickly, so that small amounts of chlorine or other disinfectants must be added to the water to ensure continued disinfection as the water is piped to the consumer's tap.

- A. Ozone
- B. Other undesirable by-products
- C. Chloramines and chlorine dioxide
- D. None of the Above

172. Modifying water treatment facilities to use \_\_\_\_\_ can be expensive, and ozone treatment can create other undesirable by-products that may be harmful to health if they are not controlled (e.g., bromate).

- A. Ozone
- B. Other undesirable by-products
- C. Chloramines and chlorine dioxide
- D. Chlorination by-products
- E. None of the Above

173. Examples of other disinfectants include \_\_\_\_\_.

- A. Ozone
- B. Other undesirable by-products
- C. Chloramines and chlorine dioxide
- D. Chlorination by-products
- E. None of the Above

174. \_\_\_\_\_ are weaker disinfectants than chlorine, especially against viruses and protozoa; however, they are very persistent and, as such, can be useful for preventing re-growth of microbial pathogens in drinking water distribution systems.

- A. Ozone
- B. Other undesirable by-products
- C. Chloramines
- D. Chlorination by-products
- E. None of the Above

175. \_\_\_\_\_ can be an effective disinfectant, but it forms chlorate and chlorite, compounds whose toxicity has not yet been fully determined.

- A. Chlorate and chlorite
- B. Chlorine dioxide
- C. Chloramines
- D. Chlorination by-products
- E. None of the Above

176. Assessments of the health risks from these and other \_\_\_\_\_ and chlorination by-products are currently under way.

- A. Chlorate and chlorite
- B. Chlorine-based disinfectants
- C. Chloramines
- D. Chlorination by-products
- E. None of the Above

177. In general, the preferred method of controlling chlorination by-products is removal of the naturally occurring organic matter from the source water so it cannot react with the \_\_\_\_\_ to form by-products.

- A. Chlorate and chlorite
- B. Chlorine
- C. Chloramines
- D. Chlorination by-products
- E. None of the Above

178. THM levels may also be reduced through the replacement of chlorine with \_\_\_\_\_.

- A. Chlorate and chlorite
- B. Other undesirable by-products
- C. Chloramines
- D. Alternative disinfectants
- E. None of the Above

179. A third option is removal of the by-products by adsorption on\_\_\_\_\_. It is extremely important that water treatment plants ensure that methods used to control chlorination by-products do not compromise the effectiveness of water disinfection.

- A. Chlorate and chlorite
- B. Other undesirable by-products
- C. Chloramines
- D. Activated carbon beds
- E. None of the Above

#### **Chlorine Section Chapter 4 Assignment**

##### **Chlorine's Appearance and Odor**

180. Chlorine is a greenish-yellow gas with a\_\_\_\_\_. It condenses to an amber liquid at approximately -34 degrees C (-29.2 degrees F) or at high pressures.

- A. Characteristic pungent odor
- B. Greenish-yellow gas
- C. Corrosive material
- D. Olfactory fatigue
- E. None of the Above

181. Odor thresholds ranging from 0.08 to part per million (ppm) parts of air have been reported. Prolonged exposures may result in \_\_\_\_\_.

- A. Vapors form explosive mixtures
- B. Olfactory fatigue
- C. Combustible substances
- D. Will attack
- E. None of the Above

##### **Reactivity**

182. Conditions Contributing to Instability: Cylinders of chlorine may burst when exposed to elevated temperatures. Chlorine in solution forms a \_\_\_\_\_.

- A. Sulfur dioxide
- B. Greenish-yellow gas
- C. Corrosive material
- D. Olfactory fatigue
- E. None of the Above

183. Incompatibilities: Flammable gases and \_\_\_\_\_ with chlorine.

- A. Vapors form explosive mixtures
- B. Olfactory fatigue
- C. Combustible substances
- D. Will attack
- E. None of the Above

184. Contact between chlorine and many \_\_\_\_\_ (such as gasoline and petroleum products, hydrocarbons, turpentine, alcohols, acetylene, hydrogen, ammonia, and sulfur), reducing agents, and finely divided metals may cause fires and explosions. 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. Vapors form explosive mixtures
- B. Olfactory fatigue
- C. Combustible substances
- D. Will attack
- E. None of the Above

185. Chlorine reacts with \_\_\_\_\_ and water to form hydrochloric acid, and it reacts with carbon monoxide and sulfur dioxide to form phosgene and sulfuryl chloride. Chlorine is also incompatible with moisture, steam, and water.

- A. Sulfur dioxide
- B. Greenish-yellow gas
- C. Corrosive material
- D. Hydrogen sulfide
- E. None of the Above

186. Special Precautions: Chlorine \_\_\_\_\_ some forms of plastics, rubber, and coatings.

- A. Vapors form explosive mixtures
- B. Olfactory fatigue
- C. Combustible substances
- D. Will attack
- E. None of the Above

**Fires involving chlorine should be fought upwind from the maximum distance possible.**

187. 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,

- \_\_\_\_\_.
- A. Self- contained breathing apparatus
  - B. Chlorine may explode
  - C. Isolate the hazard area and deny entry
  - D. Withdraw from the area and let the fire burn
  - E. None of the Above

188. Emergency personnel should stay out of \_\_\_\_\_ before entering.

- A. Self- contained breathing apparatus
- B. Chlorine may explode
- C. Isolate the hazard area and deny entry
- D. Low areas and ventilate closed spaces
- E. None of the Above

189. \_\_\_\_\_ and should be moved from the fire area if it is possible to do so safely. If this is not possible, cool fire exposed containers from the sides with water until well after the fire is out.

- A. Self- contained breathing apparatus
- B. Containers of chlorine may explode in the heat of the fire
- C. Isolate the hazard area and deny entry
- D. Low areas and ventilate closed spaces
- E. None of the Above

190. Stay away from the ends of containers. Firefighters should wear a full set of protective clothing and \_\_\_\_\_ when fighting fires involving chlorine.

- A. Self- contained breathing apparatus
- B. Chlorine may explode
- C. Isolate the hazard area and deny entry
- D. Low areas and ventilate closed spaces
- E. None of the Above

## Chlorine Exposure Limits

### OSHA PEL

201. The current OSHA permissible exposure limit (\_\_\_\_\_) for chlorine is 1 ppm (3 milligrams per cubic meter ( $\text{mg}/\text{m}^3$ )) as a ceiling limit. A worker's exposure to chlorine shall at no time exceed this ceiling level.

- A. PEL
- B. ACGIH
- C. NIOSH
- D. TLV
- E. None of the Above

### NIOSH REL

202. The National Institute for Occupational Safety and Health (NIOSH) has established a recommended exposure limit (\_\_\_\_\_) for chlorine of 0.5 ppm ( $\text{mg}/\text{m}^3$ ) as a TWA for up to a 10-hour workday and a 40-hour workweek and a short-term exposure limit (STEL) of 1 ppm ( $\text{mg}/\text{m}^3$ ).

- A. PEL
- B. STEL
- C. REL
- D. TLV
- E. None of the Above

### ACGIH TLV

203. The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned chlorine a threshold limit value (\_\_\_\_\_) of 0.5 ppm ( $\text{mg}/\text{m}^3$ ) as a TWA for a normal 8-hour workday and a 40-hour workweek and a STEL of 1 ppm ( $\text{mg}/\text{m}^3$ ) for periods not to exceed 15 minutes. Exposures at the STEL concentration should not be repeated more than four times a day and should be separated by intervals of at least 60 minutes.

- A. PEL
- B. ACGIH
- C. NIOSH
- D. TLV
- E. None of the Above

### Rationale for Limits

204. The NIOSH limits are based on the risk of severe eye, mucous membrane and skin irritation. The \_\_\_\_\_ limits are based on the risk of eye and mucous membrane irritation.

- A. PEL
- B. ACGIH
- C. NIOSH
- D. TLV
- E. None of the Above

### What Happens to Chlorine When it Enters the Environment?

205. When released to air, \_\_\_\_\_ will react with water to form hypochlorous acid and hydrochloric acid, which are removed from the atmosphere by rainfall.

- A. Hydrochloric acid
- B. Hypochlorous acid
- C. Chlorine
- D. Gas
- E. None of the Above

206. Chlorine is slightly soluble in water. It reacts with water to form hypochlorous acid and \_\_\_\_\_.

- A. Hydrochloric acid
- B. Hypochlorous acid
- C. Chlorine
- D. None of the Above

207. The \_\_\_\_\_ breaks down rapidly. The hydrochloric acid also breaks down; its breakdown products will lower the pH of the water (makes it more acidic).

- A. Hydrochloric acid
- B. Hypochlorous acid
- C. Chlorine
- D. Gas
- E. None of the Above

208. Since chlorine is a gas it is rarely found in soil. If released to soil, chlorine will react with moisture forming \_\_\_\_\_. These compounds can react with other substances found in soil.

- A. Hydrochloric acid
- B. Hypochlorous acid
- C. Chlorine
- D. Hypochlorous acid and hydrochloric acid
- E. None of the Above

209. \_\_\_\_\_ does not accumulate in the food chain.

- A. Hydrochloric acid
- B. Hypochlorous acid
- C. Chlorine
- D. Gas
- E. None of the Above

#### **Disinfectant Qualities**

210. Restaurants and meat and poultry processing plants rely on chlorine bleach and other chlorine-based products to kill harmful levels of bacteria such as \_\_\_\_\_ on food preparation surfaces and during food processing.

- A. Chlorine and chlorine compounds
- B. Bacteria
- C. Salmonella and E. coli
- D. Chlorine-based disinfectants
- E. None of the Above

211. Chlorine is so important in poultry processing that the US Department of Agriculture requires an almost constant chlorine rinse for much of the cutting equipment. In fact, no proven economical alternative to \_\_\_\_\_ exists for use in meat and poultry processing facilities.

- A. Chlorine-based disinfectants
- B. Chlorine
- C. Chlorine disinfection
- D. Free element
- E. None of the Above

#### **Properties**

212. Because it is highly reactive, chlorine is usually found in nature bound with other elements like \_\_\_\_\_.

- A. Chlorine and chlorine compounds
- B. Bacteria
- C. Sodium, potassium, and magnesium
- D. Chlorine-based disinfectants
- E. None of the Above

213. When chlorine is isolated as a \_\_\_\_\_, chlorine is a greenish yellow gas, which is 2.5 times heavier than air. It turns to a liquid state at  $-34^{\circ}\text{C}$  ( $-29^{\circ}\text{F}$ ), and it becomes a yellowish crystalline solid at  $-103^{\circ}\text{C}$  ( $-153^{\circ}\text{F}$ ).

- A. Chlorine-based disinfectants
- B. Chlorine
- C. Organic compounds
- D. Free element
- E. None of the Above

214. Chemists began experimenting with \_\_\_\_\_ in the 18th century. They learned that chlorine has an extraordinary ability to extend a chemical bridge between various elements and compounds that would not otherwise react with each other.

- A. Chlorine and chlorine compounds
- B. Bacteria
- C. Sodium, potassium, and magnesium
- D. Chlorine-based disinfectants
- E. None of the Above

215. Chlorine has been especially useful in studying and synthesizing organic compounds -- compounds that have at least one atom of the element carbon in their molecular structure. All living organisms, including humans, are composed of \_\_\_\_\_.

- A. Chlorine-based disinfectants
- B. Chlorine
- C. Organic compounds
- D. Free element
- E. None of the Above

216. Chlorine is one of the most abundant chemical elements on Earth. It is ubiquitous in soils, minerals, plants and animals. Seawater is a huge reservoir of \_\_\_\_\_ weathered from the continents and transported to the oceans by Earth's rivers.

- A. Chlorine and chlorine compounds
- B. Dissolved chlorine
- C. Sodium, potassium, and magnesium
- D. Chlorine-based disinfectants
- E. None of the Above

217. Chlorine is also one of the most useful chemical elements. Each chemical element has its own set of unique properties and chlorine is known as a \_\_\_\_\_--so reactive, in fact, that it is usually found combined with other elements in the form of compounds. More than 3,500 naturally occurring chlorinated organic (associated with living organisms) compounds alone have been identified.

- A. Chlorine-based disinfectants
- B. Chlorine
- C. Very reactive element
- D. Free element
- E. None of the Above

218. \_\_\_\_\_ have been harnessed innovatively for good use. For example, this element plays a huge role in public health.

- A. Chlorine and chlorine compounds
- B. Chlorine's chemical properties
- C. Sodium, potassium, and magnesium
- D. Chlorine-based disinfectants
- E. None of the Above

219. \_\_\_\_\_ are capable of removing a wide variety of disease-causing germs from drinking water and wastewater as well as from hospital and food production surfaces.
- A. Chlorine-based disinfectants
  - B. Chlorine
  - C. Organic compounds
  - D. Free element
  - E. None of the Above

### Chlorine Gas Section Assignment

#### Chlorine Gas

220. Background: Chlorine gas is a pulmonary irritant with \_\_\_\_\_ that causes acute damage in the upper and lower respiratory tract.

- A. It readily dissociates
- B. Intermediate water solubility
- C. Is non-selective
- D. Easy to feed and is quite inexpensive
- E. None of the Above

221. Chlorine is a \_\_\_\_\_ at standard temperature and pressure. It is extremely reactive with most elements. Because its density is greater than that of air, the gas settles low to the ground. It is a respiratory irritant, and it burns the skin.

- A. Yellowish-green gas
- B. More HOCl is present
- C. Hydrochloric acid (HCl)
- D. Extremely reactive with most elements
- E. None of the Above

222. Chlorine gas is likely the \_\_\_\_\_. It has traditionally been the biocide of choice in many cooling water treatment systems. It is a strong oxidizer that is relatively easy to feed and is quite inexpensive.

- A. It readily dissociates
- B. Intermediate water solubility
- C. Most widely used oxidizing microbiocide
- D. Easy to feed and is quite inexpensive
- E. None of the Above

223. Upon introduction into the water stream, chlorine hydrolyzes into hypochlorous acid (HOCl) and \_\_\_\_\_.

- A. React with HOCl
- B. More HOCl is present
- C. Hydrochloric acid (HCl)
- D. Extremely reactive with most elements
- E. None of the Above

224. This hydrolyzation provides the active toxicant, HOCl, which is pH-dependent. In alkaline cooling systems, \_\_\_\_\_ to form the hypochlorite ion (OCl<sup>-</sup>). This dissociation phenomenon is important to remember when working with systems that will operate at a higher pH.

- A. It readily dissociates
- B. Intermediate water solubility
- C. Is non-selective
- D. Easy to feed and is quite inexpensive
- E. None of the Above

225. In alkaline conditions,  $\text{OCl}^-$  becomes the predominant species and lacks the biocidal efficacy of \_\_\_\_\_. Considerably more  $\text{HOCl}$  is present at a pH of 7.0 than at pH 8.5.

- A. The non-dissociated form
- B. More  $\text{HOCl}$  is present
- C. Hydrochloric acid ( $\text{HCl}$ )
- D. Extremely reactive with most elements
- E. None of the Above

226. It is also widely known that \_\_\_\_\_, making it very sensitive to contamination from either cooling water makeup or from in-plant process leaks.

- A. It readily dissociates
- B. Intermediate water solubility
- C. Chlorine is non-selective
- D. Easy to feed and is quite inexpensive
- E. None of the Above

227. Ammonia, organic acids and organic compounds, sulfides, iron and manganese all easily \_\_\_\_\_.

- A. React with  $\text{HOCl}$
- B. More  $\text{HOCl}$  is present
- C. Hydrochloric acid ( $\text{HCl}$ )
- D. Extremely reactive with most elements
- E. None of the Above

228. The amount of chlorine needed to react with these contamination species is referred to as chlorine demand and \_\_\_\_\_ before active  $\text{HOCl}$  is available to provide a free chlorine residual.

- A. It readily dissociates
- B. Intermediate water solubility
- C. Is non-selective
- D. It must be satisfied
- E. None of the Above

229. The combination of \_\_\_\_\_ in process-contaminated systems and the dissociation process in alkaline systems creates the need for greater chlorine feed to obtain the same microbial efficacy. This results in a higher concentration of  $\text{HCl}$  in the cooling system.

- A. High chlorine demand
- B. Higher concentration of  $\text{HCl}$
- C. Odor threshold
- D. Chloride ion ( $\text{Cl}^-$ )
- E. None of the Above

230. Since  $\text{HCl}$  removes alkalinity, pH depression and system corrosion could occur. In low pH water the passive metal oxide layers protecting \_\_\_\_\_, exposing the surface to corrosion.

- A. Moderate water solubility
- B. Directly attack traditional organic-based corrosion inhibitors
- C. The metal may resolubilize
- D. Biological activity are poorly understood
- E. None of the Above

231. At free mineral acidity (pH <4.3), many passivating inhibitors become ineffective, and corrosion will proceed rapidly. Increased chloride may also have a negative impact on system corrosion. The \_\_\_\_\_ can damage or penetrate the passive oxide layer, leading to localized damage of the metal surface.

- A. Greenish-yellow, noncombustible gas
- B. Higher concentration of HCl
- C. Odor threshold
- D. Chloride ion (Cl<sup>-</sup>)
- E. None of the Above

232. High chlorine concentrations have also been shown to directly attack traditional organic-based corrosion inhibitors. When these inhibitors are " \_\_\_\_\_," the metal surface would then be susceptible to corrosion.

- A. Solubility
- B. Corrosion inhibitors
- C. Deactivated
- D. Biological activity
- E. None of the Above

### **Pathophysiology**

233. Chlorine is a \_\_\_\_\_ at room temperature and atmospheric pressure. The intermediate water solubility of chlorine accounts for its effect on the upper airway and the lower respiratory tract.

- A. Greenish-yellow, noncombustible gas
- B. Higher concentration of HCl
- C. Odor threshold
- D. Chloride ion (Cl<sup>-</sup>)
- E. None of the Above

234. Exposure to chlorine gas may be prolonged because its moderate water solubility may not cause upper airway symptoms for several minutes. In addition, the density of the gas is greater than that of air, causing it to remain near ground level and \_\_\_\_\_.

- A. Moderate water solubility
- B. Directly attack traditional organic-based corrosion inhibitors
- C. Increasing exposure time
- D. Biological activity are poorly understood
- E. None of the Above

235. The \_\_\_\_\_ for chlorine is approximately 0.3-0.5 parts per million (ppm); however, distinguishing toxic air levels from permissible air levels may be difficult until irritative symptoms are present.

- A. Greenish-yellow, noncombustible gas
- B. Higher concentration of HCl
- C. Odor threshold
- D. Chloride ion (Cl<sup>-</sup>)
- E. None of the Above

### **Mechanism of Activity**

236. The mechanisms of the above biological activity are poorly understood and the predominant anatomic site of injury may vary, depending on the chemical species produced. Cellular injury is believed to result from the \_\_\_\_\_ in cell components, from reactions with tissue water to form hypochlorous and hydrochloric acid, and from the generation of free oxygen radicals.

- A. Moderate water solubility
- B. Directly attack traditional organic-based corrosion inhibitors
- C. Oxidation of functional groups
- D. None of the Above

237. The gas comes out of the cylinder through a gas regulator. The cylinders are on a scale that operators use to measure the\_\_\_\_\_. The chains are used to prevent the tanks from falling over.

- A. Multiple pulmonary thromboses
- B. Amount used each day
- C. Ocular conjunctivae
- D. Immediate effects
- E. None of the Above

238. Chlorine gas is \_\_\_\_\_that have panic bar equipped doors. Operators have the equipment necessary to reduce the impact of a gas leak, but rely on trained emergency response teams to contain leaks.

- A. Pulmonary capillary integrity
- B. Alveoli with edema fluid
- C. Stored in vented rooms
- D. Chlorine
- E. None of the Above

### **Solubility Effects**

239. Hydrochloric acid is highly soluble in water. The predominant targets of the acid are the epithelia of the ocular conjunctivae and\_\_\_\_\_. Hypochlorous acid is also highly water soluble with an injury pattern similar to hydrochloric acid. Hypochlorous acid may account for the toxicity of elemental chlorine and hydrochloric acid to the human body.

- A. Multiple pulmonary thromboses
- B. Upper respiratory mucus membranes
- C. Ocular conjunctivae
- D. Immediate effects
- E. None of the Above

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

240. Chlorine gas, when mixed with ammonia, reacts to form chloramine gas. In the presence of water, chloramines decompose to ammonia and hypochlorous acid or hydrochloric acid. The early response to chlorine exposure depends on the (1) concentration of chlorine gas, (2) duration of exposure, (3) water content of the tissues exposed, and (4)\_\_\_\_\_.

- A. Pulmonary capillary integrity
- B. Alveoli with edema fluid
- C. Tissues exposed
- D. Individual susceptibility
- E. None of the Above

### **Immediate Effects**

241. The immediate effects of chlorine gas toxicity include \_\_\_\_\_of the conjunctivae, nose, pharynx, larynx, trachea, and bronchi. Irritation of the airway mucosa leads to local edema secondary to active arterial and capillary hyperemia.

- A. Multiple pulmonary thromboses
- B. Measure the amount used each day
- C. Ocular conjunctivae
- D. Acute inflammation
- E. None of the Above

242. \_\_\_\_\_results in filling the alveoli with edema fluid, resulting in pulmonary congestion.

- A. Pulmonary capillary integrity
- B. Alveoli with edema fluid
- C. Plasma exudation
- D. None of the Above

### Pathological Findings

243. Pathologic findings are nonspecific. They include severe \_\_\_\_\_, pneumonia, hyaline membrane formation, multiple pulmonary thromboses, and ulcerative tracheobronchitis.

- A. Multiple pulmonary thromboses
- B. Measure the amount used each day
- C. Ocular conjunctivae
- D. Pulmonary edema
- E. None of the Above

244. The hallmark of \_\_\_\_\_ associated with chlorine toxicity is pulmonary edema, manifested as hypoxia. Noncardiogenic pulmonary edema is thought to occur when there is a loss of pulmonary capillary integrity.

- A. Pulmonary capillary integrity
- B. Alveoli with edema fluid
- C. Tissues exposed
- D. Pulmonary injury
- E. None of the Above

### Amperometric Titration

245. The chlorination of water supplies and polluted waters serves primarily to destroy or deactivate \_\_\_\_\_. A secondary benefit, particularly in treating drinking water, is the overall improvement in water quality resulting from the reaction of chlorine with ammonia, iron, manganese, sulfide, and some organic substances.

- A. Certain nitrogenous compounds
- B. Analytical determination
- C. Disease-producing microorganisms
- D. Hypochlorous acid and hypochlorite ion
- E. None of the Above

246. Chlorination may produce adverse effects. Taste and odor characteristics of phenols and other organic compounds present in a water supply may be intensified. Potentially \_\_\_\_\_ may be formed.

- A. Monochloramine, dichloramine, and nitrogen trichloride
- B. Chlorine-to-nitrogen ratio
- C. Ammonia or ammonium salts
- D. Carcinogenic chloro-organic compounds such as chloroform
- E. None of the Above

247. Combined chlorine formed on chlorination of \_\_\_\_\_ adversely affects some aquatic life. To fulfill the primary purpose of chlorination and to minimize any adverse effects, it is essential that proper testing procedures be used with a foreknowledge of the limitations of the analytical determination.

- A. Certain nitrogenous compounds
- B. Analytical determination
- C. Ammonia- or amine-bearing waters
- D. Hypochlorous acid and hypochlorite ion
- E. None of the Above

248. Chlorine applied to water in its molecular or hypochlorite form initially undergoes hydrolysis to form free chlorine consisting of \_\_\_\_\_, hypochlorous acid, and hypochlorite ion.

- A. Monochloramine, dichloramine, and nitrogen trichloride
- B. Chlorine-to-nitrogen ratio
- C. Ammonia or ammonium salts
- D. Aqueous molecular chlorine
- E. None of the Above

249. The relative proportion of these free chlorine forms is pH- and temperature-dependent. At the pH of most waters, hypochlorous acid and \_\_\_\_\_ will predominate.

- A. Certain nitrogenous compounds
- B. Analytical determination
- C. Ammonia, iron, manganese, sulfide, and some organic substances
- D. Hypochlorite ion
- E. None of the Above

250. Free chlorine reacts readily with \_\_\_\_\_ and certain nitrogenous compounds to form combined chlorine.

- A. Ammonia
- B. Analytical determination
- C. Ammonia, iron, manganese, sulfide, and some organic substances
- D. Hypochlorous acid and hypochlorite ion
- E. None of the Above

251. With ammonia, chlorine reacts to form the \_\_\_\_\_: monochloramine, dichloramine, and nitrogen trichloride.

- A. Monochloramine, dichloramine, and nitrogen trichloride
- B. Chlorine-to-nitrogen ratio
- C. Ammonia or ammonium salts
- D. Chloramines
- E. None of the Above

252. The presence and concentrations of these combined forms depend chiefly on pH, temperature, initial \_\_\_\_\_, absolute chlorine demand, and reaction time. Both free and combined chlorine may be present simultaneously.

- A. Monochloramine, dichloramine, and nitrogen trichloride
- B. Chlorine-to-nitrogen ratio
- C. Ammonia or ammonium salts
- D. Aqueous molecular chlorine
- E. None of the Above

253. Combined chlorine in water supplies may be formed in the treatment of raw waters containing ammonia or by the addition of \_\_\_\_\_.

- A. Monochloramine, dichloramine, and nitrogen trichloride
- B. Chlorine-to-nitrogen ratio
- C. Ammonia or ammonium salts
- D. Aqueous molecular chlorine
- E. None of the Above

### **Sodium Hypochlorite Section Incompatibilities**

254. \_\_\_\_\_ react explosively or form explosive compounds with many common substances such as ammonia, amines, charcoal, or organic sulfides

- A. pH of the water
- B. Calcium or sodium hypochlorite
- C. Hypochlorite form of chlorine
- D. Major co-products
- E. None of the Above

## Introduction

255. The world's most universal and reliable means of water and wastewater disinfection is chlorination. \_\_\_\_\_ include gas chlorination ( $\text{Cl}_2$ ) and liquid chlorination ( $\text{NaOCl}$ ) otherwise known as

Sodium Hypochlorite.

- A. Two fundamental methods
- B. Bisulfate or muriatic acid
- C. An excellent disinfectant/antimicrobial agent
- D. Water and wastewater disinfection
- E. None of the Above

256. Sodium hypochlorite ( $\text{NaOCl}$ ) is a solution made from reacting chlorine with a sodium hydroxide solution. These two reactants \_\_\_\_\_ from most chlor-alkali cells.

- A. pH of the water
- B. Calcium or sodium hypochlorite
- C. Hypochlorite form of chlorine
- D. Are the major co-products
- E. None of the Above

257. Sodium hypochlorite has a variety of uses and is \_\_\_\_\_.

- A. Sodium hypochlorite application
- B. Bisulfate or muriatic acid
- C. An excellent disinfectant/antimicrobial agent
- D. Water and wastewater disinfection
- E. None of the Above

258. Sodium hypochlorite also \_\_\_\_\_.

- A. Lowers the pH of the water
- B. Calcium or sodium hypochlorite
- C. Hypochlorite form of chlorine
- D. Significantly increases the pH of the water
- E. None of the Above

259. When sodium hypochlorite is used, it must be counterbalanced by a strong acid like sodium bisulfate or muriatic acid to keep the \_\_\_\_\_.

- A. Sodium hypochlorite application
- B. Bisulfate or muriatic acid
- C. pH within the ideal range
- D. Water and wastewater disinfection
- E. None of the Above

260. The hypochlorite form of chlorine has been used since 1850. The most widely used form of hypochlorite is the liquid, \_\_\_\_\_, with more than 150 tons per day consumed in the United States.

- A. pH of the water
- B. Calcium hypochlorite
- C. Hypochlorite form of chlorine
- D. Sodium hypochlorite ( $\text{NaOCl}$ )
- E. None of the Above

261. Sodium hypochlorite application in cooling water is essentially the same as with gas chlorine;  $\text{HOCl}$  is produced \_\_\_\_\_. The  $\text{HOCl}$  is equally susceptible to process contamination, has the same chlorine demand as gas chlorine and displays the same tendency to dissociate.

- A. Sodium hypochlorite application
- B. Bisulfate or muriatic acid
- C. As the active toxicant
- D. None of the Above

262. Sodium hypochlorite differs from chlorine gas in \_\_\_\_\_: method of feed and hydrolyzation properties.

- A. Two respects
- B. Calcium or sodium hypochlorite
- C. Hypochlorite form of chlorine
- D. Major co-products
- E. None of the Above

263. Sodium hypochlorite can either be \_\_\_\_\_ or applied with a metering pump. The latter is generally recognized as a consistently more accurate method. The second difference, in hydrolysis, lies in the end products. The NaOCl reaction with water liberates sodium hydroxide (NaOH).

- A. Sodium hypochlorite
- B. Hydrolysis
- C. Chloride ion
- D. Gravity-fed
- E. None of the Above

264. The addition of NaOH differs in that it tends to \_\_\_\_\_. In large concentrations it may artificially elevate pH, leading to precipitation of calcium carbonate.

- A. Strong oxidator
- B. A bleaching agent
- C. Slightly yellowish solution with a characteristic odor
- D. Add alkalinity to the water
- E. None of the Above

265. While NaOCl eliminates low pH corrosion as a concern, the use of large quantities in contaminated systems still introduces a high concentration of the chloride ion, which can be very aggressive to cooling system metals. Many of the other problems associated with chlorine remain present with \_\_\_\_\_.

- A. Sodium hypochlorite
- B. Hydrolysis
- C. Chloride ion
- D. Heated sodium hypochlorite
- E. None of the Above

#### **Characteristics of Sodium hypochlorite**

266. Sodium hypochlorite is a clear, \_\_\_\_\_.

- A. Strong oxidator
- B. A bleaching agent
- C. Slightly yellowish solution with a characteristic odor
- D. Leading to precipitation of calcium carbonate
- E. None of the Above

267. \_\_\_\_\_ has a relative density of 1,1 (5,5% watery solution).

- A. Sodium hypochlorite
- B. Hydrolysis
- C. Chloride ion
- D. Heated sodium hypochlorite
- E. None of the Above

268. As a bleaching agent for domestic use it usually contains 5% sodium hypochlorite (with a pH of around 11, it is irritating). If it is more concentrated, it contains a concentration \_\_\_\_\_ (with a pH of around 13, it burns and is corrosive).

- A. Strong oxidator
- B. A bleaching agent
- C. Slightly yellowish solution with a characteristic odor
- D. 10-15% sodium hypochlorite
- E. None of the Above

269. \_\_\_\_\_ is unstable. Chlorine evaporates at a rate of 0,75 gram active chlorine per day from the solution. Then heated sodium hypochlorite disintegrates. This also happens when sodium hypochlorite comes in contact with acids, sunlight, certain metals and poisonous and corrosive gasses, including chlorine gas.

- A. Sodium hypochlorite
- B. Hydrolysis
- C. Chloride ion
- D. Heated sodium hypochlorite
- E. None of the Above

270. Sodium hypochlorite is a \_\_\_\_\_ and reacts with flammable compounds and reductors. Sodium hypochlorite solution is a weak base that is inflammable. These characteristics must be kept in mind during transport, storage and use of sodium hypochlorite.

- A. Strong oxidator
- B. A bleaching agent
- C. Slightly yellowish solution with a characteristic odor
- D. Leading to precipitation of calcium carbonate
- E. None of the Above

#### **pH value When Sodium Hypochlorite is Added to Water**

271. Due to the presence of \_\_\_\_\_ in sodium hypochlorite, the pH of the water is increased. When sodium hypochlorite dissolves in water, two substances form, which play a role in oxidation and disinfection. These are hypochlorous acid (HOCl) and the less active hypochlorite ion (OCl<sup>-</sup>).

- A. Sodium hypochlorite
- B. Hydrolysis
- C. Chloride ion
- D. Caustic soda
- E. None of the Above

272. The pH of the water determines how much hypochlorous acid is formed. While sodium hypochlorite is used, \_\_\_\_\_ is used to lower the pH. Sulfuric acid (H<sub>2</sub>SO<sub>4</sub>) can be used as an alternative for acetic acid. Less harmful gasses are produced when sulfuric acid is used.

- A. Sodium hypochlorite
- B. Hydrolysis
- C. Chloride ion
- D. Acetic acid (HCl)
- E. None of the Above

273. \_\_\_\_\_ is a strong acid that strongly reacts with bases and is very corrosive.

- A. Sodium hypochlorite
- B. Hydrolysis
- C. Chloride ion
- D. Sulfuric acid
- E. None of the Above

274. Hypochlorite neutralizes \_\_\_\_\_. It is also used to detoxify cyanide baths in metal industries. Hypochlorite can be used to prevent algae and shellfish growth in cooling towers. In water treatment, hypochlorite is used to disinfect water. In households, hypochlorite is used frequently for the purification and disinfection of the house.

- A. Sodium hypochlorite
- B. Hydrolysis
- C. Chloride ion
- D. Sulfur hydrogen gas (SH) and ammonia (NH<sub>3</sub>)
- E. None of the Above

### **Respiratory Protection Assignment**

#### **True or False Section**

275. The Employee is required to retain written information regarding medical evaluations, fit testing, and the respirator program.

- A. True
- B. False

276. This information may facilitate employee involvement in the respirator program, assist the Employee in auditing the adequacy of the program, and provide a record for compliance determinations by EPA.

- A. True
- B. False

277. Effective training for employees who are required to use respirators is helpful.

- A. True
- B. False

278. The training may be comprehensive, understandable, and recur bi-annually and more often if necessary.

- A. True
- B. False

279. Training will be provided prior to requiring the employee to use a respirator in the workplace.

- A. True
- B. False

**The training shall ensure that each employee can demonstrate knowledge of at least the following:**

280. Why the respirator is necessary and how improper fit, usage, or maintenance can compromise the protective effect of the respirator

- A. True
- B. False

281. Limitations and capabilities of OSHA

- A. True
- B. False

282. How to use the respirator effectively in emergency situations, including situations in which the respirator malfunctions

- A. True
- B. False

283. How to inspect, put on and remove, use, and check the seals of a transmission

- A. True
- B. False

284. What the procedures are for maintenance and storage of the respirator

- A. True
- B. False

285. How not to recognize medical signs and symptoms that may not limit or prevent the effective use of respirators

- A. True
- B. False

**Retraining shall be conducted annually and when:**

286. Changes in the workplace or the type of respirator render previous training obsolete.

- A. True
- B. False

287. Adequacies in the employee's knowledge or use of the respirator indicate that the employee has retained the requisite understanding or skill.

- A. True
- B. False

288. Other situation arises in which retraining appears necessary to ensure safe respirator use.

- A. True
- B. False

289. Only authorized and trained Respirators may use Respirators.

- A. True
- B. False

290. Those Employees may use only the Respirator that they have been trained on and properly fitted to use.

- A. True
- B. False

291. Only Mentally Unqualified Employees may be trained and authorized to use Respirators.

- A. True
- B. False

292. A pre-authorization and annual certification by a qualified physician will be required and maintained. Any changes in an Employees health or physical characteristics will be reported to the Occupational Health Department and will be evaluated by a qualified physician.

- A. True
- B. False

293. Only the proper prescribed dust mask or OSHA may be used for the job or work environment.

- A. True
- B. False

294. Employees working in environments where a sudden release of a hazardous substance is likely will wear an appropriate respirator for that hazardous substance (example: Employees working in an ammonia compressor room will have an ammonia APR respirator on their person.).

- A. True
- B. False

295. Only SCBAs will be used in oxygen deficient environments, environments with an unknown hazardous substance or unknown quantity of a known hazardous substance or any environment that is determined "Immediately Dangerous to Life or Health" (IDLH).

- A. True
- B. False

296. Employees with respirators loaned on "permanent check out" will be responsible for the sanitation, proper storage and security.

- A. True
- B. False

297. Respirators damaged by abnormal wear will be repaired or replaced by the Employee when returned.

- A. True
- B. False

300. The first Employee using a respirator and/or SCBA that are available for general use will be responsible for proper storage and sanitation.

- A. True
- B. False

301. Monthly and after each use, all respirators will be inspected with documentation to assure its availability for use.

- A. True
- B. False

302. All respirators will be located in a clean, convenient and sanitary location.

- A. True
- B. False

303. In the event that Employees must enter a confined space, work in environments with hazardous substances that would be dangerous to life or health should an RPE fail (a SCBA is required in this environment), and/or conduct a HAZMAT entry, a "buddy system" detail will be used with a Safety Watchman with constant voice, visual or signal line communication.

- A. True
- B. False

304. Employees will follow the established Emergency Response Program and/or Confined Space Entry Program when applicable.

- A. True
- B. False

305. Management will establish and maintain surveillance of jobs and work place conditions and degree of Employee exposure or stress to maintain the proper procedures and to provide the necessary RPE.

- A. True
- B. False

306. The Employer is responsible and need to have evaluated the respiratory hazard(s) in each workplace, identified relevant workplace and user factors and has based respirator selection on these factors. Also included are estimates of employee exposures to respiratory hazard(s) and an identification of the contaminant's chemical state and physical form.

- A. True
- B. False

**Filter Classifications** - These classifications are marked on the filter or filter package

**307. R-Series: Oil Resistant.** Approved for non-oil particulate contaminants

Examples: dust, fumes, mists not containing oil

- A. True
- B. False

**N-Series: Not Oil Resistant**

308. Approved for all particulate contaminants, including those containing oil

Examples: dusts, mists, fumes, Time restriction of 8 hours when oils are present

- A. True
- B. False

**K-Series: Oil Proof**

309. Approved for all particulate contaminants including those containing oil

Examples: dust, fumes, mists, See Manufacturer's time use restrictions on packaging

- A. True
- B. False

**Respirators for IDLH atmospheres.**

The following respirators will be used in IDLH atmospheres:

310. A full face piece pressure demand SCBA certified by OSHA for a minimum service life of thirty hours.

- A. True
- B. False

311. A combination full face piece pressure demand supplied-air respirator (SAR) with auxiliary self-contained air supply.

- A. True
- B. False

312. Respirators provided only for escape from PEL atmospheres shall be NIOSH-certified for escape from the atmosphere in which they will be used.

- A. True
- B. False

313. The respirators selected shall be adequate to protect the health of the employee and ensure compliance with all other OSHA statutory and regulatory requirements, under routine and reasonably foreseeable emergency situations.

- A. True
- B. False

314. The respirator selected shall be appropriate for the chemical state and physical form of the contaminant.

- A. True
- B. False

**The respirators shall be cleaned and disinfected when:**

315. Respirators issued for the exclusive use of an employee shall be cleaned and disinfected as often as necessary to be maintained in a sanitary condition.

- A. True
- B. False

316. Respirators issued to more than one employee do not need to be cleaned and disinfected before being worn by different individuals

- A. True
- B. False

317. Respirators maintained for emergency use shall be cleaned and disinfected after each use

- A. True
- B. False

318. Respirators used in fit testing and training shall be cleaned and disinfected after each use.

- A. True
- B. False

319. Cleaning and Storage of respirators assigned to specific employees is the responsibility of OSHA.

- A. True
- B. False

### **Respirator Inspection**

320. All respirators/SCBAs, both available for "General Use" and those on "Permanent Check-out", will be inspected after each use and at least monthly.

- A. True
- B. False

321. Should any defects be noted, the respirator/SCBA will be taken to the program Administrator.

- A. True
- B. False

322. Damaged Respirators will be either repaired or replaced. The inspection of respirators loaned on "Permanent Check-out" is the responsibility of that trained Employee.

- A. True
- B. False

323. **Respirators shall be inspected as follows:**

All respirators used in routine situations shall be inspected before each use and during cleaning

- A. True
- B. False

### **Respiratory Terms**

324. A system that warns the respirator user of the approach of the end of adequate respiratory protection; for example, that the sorbent is approaching saturation or is no longer effective.

- A. Filter or Air-Purifying Element
- B. Escape Gas Mask
- C. Escape Only Respirator
- D. End-Of-Service-Life Indicator
- E. None of the Above

325. A gas mask that consists of a half-mask facepiece or mouthpiece, a canister, and associated connections, and that is designed for use during escape-only from hazardous atmospheres.

- A. Filter or Air-Purifying Element
- B. Escape Gas Mask
- C. Escape Only Respirator
- D. End-Of-Service-Life Indicator
- E. None of the Above

326. Respiratory devices that are designed for use only during escape from hazardous atmospheres.

- A. Filter or Air-Purifying Element
- B. Escape Gas Mask
- C. Escape Only Respirator
- D. End-Of-Service-Life Indicator
- E. None of the Above

327. A respirator intended to be used only for emergency exit.

- A. Filter or Air-Purifying Element
- B. Escape Gas Mask
- C. Escape Only Respirator
- D. End-Of-Service-Life Indicator
- E. None of the Above

328. The penetration of challenge material(s) through a gas or a vapor air-purifying element. The quantity or extent of breakthrough during service life testing is often referred to as the percentage of the input concentration.

- A. Filter or Air-Purifying Element
- B. Escape Gas Mask
- C. Escape Only Respirator
- D. Breakthrough
- E. None of the Above

329. A component used in respirators to remove solid or liquid aerosols from the inspired air.

- A. Filter or Air-Purifying Element
- B. Escape Gas Mask
- C. Escape Only Respirator
- D. End-Of-Service-Life Indicator
- E. None of the Above

330. A particulate respirator with a filter as an integral part of the facepiece or with the entire facepiece composed of the filtering medium.

- A. Canister or Cartridge
- B. Air-Purifying Respirator
- C. Filtering Facepiece
- D. Disposable Respirators
- E. None of the Above

331. A negative pressure particulate respirator with a filter as an integral part of the facepiece or with the entire facepiece composed of the filtering medium.

- A. Canister or Cartridge
- B. Air-Purifying Respirator
- C. Filtering Facepiece
- D. Disposable Respirators
- E. None of the Above

332. A container with a filter, sorbent, or catalyst, or a combination of these items, which removes specific contaminants from the air passed through the container.

- A. Canister or Cartridge
- B. Air-Purifying Respirator
- C. Filtering Facepiece
- D. Disposable Respirators
- E. None of the Above

333. An atmosphere-supplying respirator that admits breathing air to the facepiece only when a negative pressure is created inside the facepiece by inhalation.

- A. Canister or Cartridge
- B. Air-Purifying Respirator
- C. Filtering Facepiece
- D. Demand Respirator
- E. None of the Above

334. A respirator that is discarded after the end of its recommended period of use, after excessive resistance or physical damage, or when odor breakthrough or other warning indicators render the respirator unsuitable for further use.

- A. Canister or Cartridge
- B. Air-Purifying Respirator
- C. Filtering Facepiece
- D. Disposable Respirators
- E. None of the Above

335. A respirator with an air-purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the air-purifying element.

- A. Canister or Cartridge
- B. Air-Purifying Respirator
- C. Filtering Facepiece
- D. Disposable Respirators
- E. None of the Above

336. A respirator that supplies the respirator user with breathing air from a source independent of the ambient atmosphere.

- A. Employee Exposure
- B. Atmosphere-Supplying Respirator
- C. Emergency Respirator Use Situation
- D. Emergency Situation
- E. None of the Above

337. A solid, mechanically produced particle with a size ranging from submicroscopic to macroscopic.

- A. Employee Exposure
- B. Atmosphere-Supplying Respirator
- C. Emergency Respirator Use Situation
- D. Emergency Situation
- E. None of the Above

338. A situation that requires the use of respirators due to the unplanned generation of a hazardous atmosphere (often of unknown composition) caused by an accident, mechanical failure, or other means and that requires evacuation of personnel or immediate entry for rescue or corrective action.

- A. Employee Exposure
- B. Atmosphere-Supplying Respirator
- C. Emergency Respirator Use Situation
- D. Emergency Situation
- E. None of the Above

339. Any occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment that may or does result in an uncontrolled significant release of an airborne contaminant.

- A. Employee Exposure
- B. Emergency Respirator Use Situation
- C. Emergency Situation
- D. None of the Above

340. Exposure to a concentration of an airborne contaminant that would occur if the employee were not using respiratory protection.

- A. Employee Exposure
- B. Atmosphere-Supplying Respirator
- C. Emergency Respirator Use Situation
- D. Emergency Situation
- E. None of the Above

341. A filter that is at least 99.97% efficient in removing monodisperse particles of 0.3 micrometers in diameter. The equivalent NIOSH 42 CFR 84 particulate filters are the N100, R100, and P100 filters.

- A. Employee Exposure
- B. High-Efficiency Particulate Air (Hepa) Filter
- C. Emergency Respirator Use Situation
- D. Emergency Situation
- E. None of the Above

342. Means a respiratory inlet covering that completely covers the head and neck and may also cover portions of the shoulders and torso.

- A. Immediately Dangerous to Life or Health
- B. Interior Structural Firefighting
- C. Hood
- D. Loose-Fitting Facepiece
- E. None of the Above

343. Acute respiratory exposure that poses an immediate threat of loss of life, immediate or delayed irreversible adverse effects on health, or acute eye exposure that would prevent escape from a hazardous atmosphere.

- A. Immediately Dangerous to Life or Health
- B. Interior Structural Firefighting
- C. Hood
- D. Loose-Fitting Facepiece
- E. None of the Above

344. An atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape from a dangerous atmosphere.

- A. Immediately Dangerous to Life or Health
- B. Interior Structural Firefighting
- C. Hood
- D. Loose-Fitting Facepiece
- E. None of the Above

345. The physical activity of fire suppression, rescue or both, inside of buildings or enclosed structures which are involved in a fire situation beyond the incipient stage.

- A. Immediately Dangerous to Life or Health
- B. Interior Structural Firefighting
- C. Hood
- D. Loose-Fitting Facepiece
- E. None of the Above

346. A respiratory inlet covering that is designed to form a partial seal with the face.

- A. Immediately Dangerous to Life or Health
- B. Interior Structural Firefighting
- C. Hood
- D. Loose-Fitting Facepiece
- E. None of the Above

347. A quantitative measure of the fit of a specific respirator facepiece to a particular individual.

- A. Fume
- B. Fit Factor
- C. Fit Test
- D. Gas
- E. None of the Above

348. A quantitative estimate of the fit of a particular respirator to a specific individual, and typically estimates the ratio of the concentration of a substance in ambient air to its concentration inside the respirator when worn.

- A. Fume
- B. Fit Factor
- C. Fit Test
- D. None of the Above

349. Means the use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual.

- A. Fume
- B. Fit Factor
- C. Fit Test
- D. Gas
- E. None of the Above

350. A solid condensation particulate, usually of a vaporized metal.

- A. Fume
- B. Fit Factor
- C. Fit Test
- D. Gas
- E. None of the Above

### Final Review

**These questions will come from various sections of the course. There are no intentional trick questions.**

351. In many cases, source water from a lake, river, reservoir or ground water aquifer needs to be disinfected to inactivate (or kill) \_\_\_\_\_.

- A. Cryptosporidium
- B. Microbial pathogens
- C. These pathogens
- D. Trihalomethanes and haloacetic acids
- E. None of the Above

352. \_\_\_\_\_ include a few types of bacteria, viruses, protozoa, and other organisms. Some pathogens are often found in water, frequently as a result of:

- Fecal matter from sewage discharges
- Leaking septic tanks
- Runoff from animal feedlots into bodies of water

- A. Sanitary disposal of excreta
- B. Microbial pathogens
- C. Disinfectant practices
- D. Microbial pathogens
- E. None of the Above

353. To protect drinking water from \_\_\_\_\_, water suppliers often add a disinfectant to drinking water such as chlorine.

- A. Cryptosporidium
- B. Microbial pathogens
- C. These pathogens
- D. Trihalomethanes and haloacetic acids
- E. None of the Above

354. Disinfectant practices can be problematic because: Certain \_\_\_\_\_, such as Cryptosporidium, are highly resistant to traditional disinfection practices.

- A. Sanitary disposal of excreta
- B. Microbial pathogens
- C. Disinfectant practices
- D. Microbial pathogens
- E. None of the Above

355. Disinfectants themselves can react with naturally-occurring materials in the water to form \_\_\_\_\_, such as trihalomethanes and haloacetic acids, which may pose health risks.

- A. Cryptosporidium
- B. Microbial pathogens
- C. Byproducts
- D. Trihalomethanes and haloacetic acids
- E. None of the Above

356. A major challenge for water suppliers is how to balance the risks from \_\_\_\_\_ and disinfection byproducts.

- A. Sanitary disposal of excreta
- B. Microbial pathogens
- C. Disinfectant practices
- D. Microbial pathogens
- E. None of the Above

357. It is important to provide protection from microbial pathogens while simultaneously minimizing health risks to the population from \_\_\_\_\_. There are several existing and future rules that are designed to achieve these goals.

- A. Cryptosporidium
- B. Disinfection byproducts
- C. These pathogens
- D. Trihalomethanes and haloacetic acids
- E. None of the Above

358. Among the main problems which are responsible for this situation are: lack of priority given to the sector, lack of financial resources, \_\_\_\_\_, poor hygiene behaviors, and inadequate sanitation in public places including hospitals, health centers and schools.

- A. Sanitary disposal of excreta
- B. Microbial pathogens
- C. Disinfectant practices
- D. Microbial pathogens
- E. None of the Above

359. Providing access to sufficient quantities of safe water, the provision of facilities for a sanitary disposal of excreta, and introducing sound hygiene behaviors are of \_\_\_\_\_ caused by these risk factors. Water, sanitation and hygiene have important impacts on both health and disease.

- A. Capital importance to reduce the burden of disease
- B. Part of their lifecycle in water
- C. Constant circumstances of exposure
- D. Inhalation of water vapors
- E. None of the Above

360. Water-related diseases include: Those due to \_\_\_\_\_ in water people drink.

- A. Harmless microbial flora
- B. Aerosols containing certain micro-organisms
- C. Micro-organisms and chemicals
- D. Opportunistic pathogens
- E. None of the Above

361. Diseases \_\_\_\_\_ which have part of their lifecycle in water.

- A. Important impacts on both health and disease
- B. Part of their lifecycle in water
- C. Constant circumstances of exposure
- D. Inhalation of water vapors
- E. None of the Above

362. Diseases like malaria with water-related vectors; drowning and some injuries; and others such as legionellosis carried by \_\_\_\_\_.

- A. Harmless microbial flora
- B. Aerosols containing certain micro-organisms
- C. Micro-organisms and chemicals
- D. Opportunistic pathogens
- E. None of the Above

### **Microorganisms are Present Everywhere in Our Environment**

363. Invisible to the naked eye, vast numbers of these microbes can be found in soil, air, food and water. Although humans are essentially free of microorganisms before birth, \_\_\_\_\_ (e.g., breathing, eating, and drinking) quickly allow the establishment of harmless microbial flora in our bodies.

- A. Important impacts on both health and disease
- B. Part of their lifecycle in water
- C. Constant circumstances of exposure
- D. Inhalation of water vapors
- E. None of the Above

364. Microbial pathogens (microorganisms capable of causing disease), however, can and often do harm those who become infected. Moreover, diseases that healthy individuals “weather” well may prove fatal to individuals with compromised immune systems. In some cases, an infection can persist to create a “carrier state” where a disease causing agent is harbored by the body (and spread) without any \_\_\_\_\_.

- A. Harmless microbial flora
- B. Aerosols containing certain micro-organisms
- C. Apparent symptoms
- D. Opportunistic pathogens
- E. None of the Above

365. Waterborne diseases are typically considered to be those diseases resulting from ingestion of contaminated water. Additional pathways of infection being studied by EPA include \_\_\_\_\_ as well as body contact during bathing (opportunistic pathogens) in the hospital environment.

- A. Important impacts on both health and disease
- B. Part of their lifecycle in water
- C. Constant circumstances of exposure
- D. Inhalation of water vapors
- E. None of the Above

366. Since \_\_\_\_\_ (drinking water) and bathing are during recreational activities (e.g., swimming, water skiing, wading) is common, inadequate protection of water integrity could lead to widespread outbreaks (the Centers for Disease Control defines an outbreak to be two or more cases of illness that can be traced to a common source).

- A. Voluntary water ingestion
- B. Aerosols containing certain micro-organisms
- C. Micro-organisms and chemicals
- D. Opportunistic pathogens
- E. None of the Above

367. Because symptoms can be mild and short-lived, it is estimated that only a fraction of waterborne outbreaks is \_\_\_\_\_. Of these, the pathogenic agent is identified only half of the time.

- A. Important impacts on both health and disease
- B. Part of their lifecycle in water
- C. Constant circumstances of exposure
- D. Recognized, reported and investigated
- E. None of the Above

368. Additionally, experts believe that some \_\_\_\_\_ may originate with an initial infection (e.g., of a restaurant worker) caused by contaminated drinking water.

- A. Food-related disease outbreaks
- B. Aerosols containing certain micro-organisms
- C. Micro-organisms and chemicals
- D. Opportunistic pathogens
- E. None of the Above

369. Bacteria, viruses and protozoa are the \_\_\_\_\_ of primary concern in the study of waterborne diseases.

- A. Increased implementation of important treatment practices
- B. Action of disinfectants
- C. Waterborne diseases
- D. Microorganism groups containing pathogens
- E. None of the Above

370. To eliminate these pathogens from our water, especially from our drinking water, seems theoretically straightforward. Simply mix in a disinfectant, allow adequate contact time to \_\_\_\_\_ (rendering the microbes unable to produce disease), and pump the water into the distribution lines.

- A. Assure inactivation
- B. Chemical reactions
- C. Inactivate pathogens
- D. Number of outbreaks
- E. None of the Above

371. In reality, many conditions render the above scenario unworkable. The \_\_\_\_\_, primarily represented by dissolved and suspended solids content, can affect the disinfection process.

- A. Increased implementation of important treatment practices
- B. Action of disinfectants
- C. Waterborne diseases of chief concern
- D. Physical characteristics of the water
- E. None of the Above

372. The chemical content, both naturally occurring and anthropogenic (i.e., generated by humans), can also interfere with the \_\_\_\_\_ desired during treatment and disinfection.

- A. Assure inactivation
- B. Chemical reactions
- C. Inactivate pathogens
- D. Number of outbreaks
- E. None of the Above

373. Finally, pathogens associated (i.e., imbedded in or clumped) with higher organisms (e.g., algae, rotifers, worms) \_\_\_\_\_

- A. Increased implementation of important treatment practices
- B. May be protected from the action of disinfectants.
- C. Waterborne diseases of chief concern
- D. Essential deterrents of pathogen entry, recovery and survival
- E. None of the Above

374. To overcome these obstacles to disinfection, successful treatment of drinking and waste water generally includes a series of steps. In the case of drinking water disinfection, once the impurities have been removed, enough disinfectant is added to \_\_\_\_\_.

- A. Assure inactivation
- B. Chemical reactions
- C. Inactivate pathogens
- D. Number of outbreaks
- E. None of the Above

### **What Progress Has Been Made?**

375. Early in this century, the \_\_\_\_\_ in the U.S. were typhoid fever and amebiasis. Of the 1,087 deaths associated with waterborne outbreaks between 1920 and 1991, 943 were attributed to typhoid fever while 102 were caused by amebiasis.

- A. Increased implementation of important treatment practices
- B. Action of disinfectants
- C. Waterborne diseases of chief concern
- D. Essential deterrents of pathogen entry, recovery and survival
- E. None of the Above

376. Overall, 83% of the deaths occurred prior to 1936 and less than 1% occurred after 1970. Additionally, the \_\_\_\_\_ in community water systems since 1945 is about half as great as the number documented during the first half of this century.

- A. Assure inactivation
- B. Chemical reactions
- C. Inactivate pathogens
- D. Number of outbreaks
- E. None of the Above

377. The \_\_\_\_\_ indicates that progress has been made in the prevention of certain waterborne diseases. Much of the progress has been the result of increased implementation of important treatment practices (e.g., filtration, disinfection, sewage treatment).

- A. Increased implementation of important treatment practices
- B. Action of disinfectants
- C. Waterborne diseases of chief concern
- D. Reduction in fatalities and number of outbreaks
- E. None of the Above

378. Although progress has been significant, the nation's water continues to be a source of disease. It must be rigorously monitored for indicators of \_\_\_\_\_.

- A. Assure inactivation
- B. Chemical reactions
- C. Inactivate pathogens
- D. Number of outbreaks
- E. None of the Above

379. A residual level of disinfectant must be maintained throughout the distribution system to \_\_\_\_\_ (e.g., microorganisms entering through breaks in distribution lines or regrowth). Proper distribution system operation and maintenance practices are essential deterrents of pathogen entry, recovery and survival.

- A. Increased implementation of important treatment practices
- B. Guard against potential problems
- C. Waterborne diseases of chief concern
- D. Essential deterrents of pathogen entry, recovery and survival
- E. None of the Above

380. These practices (according to Geldreich et al., 1992) include: Systematic flushing of the entire distribution system "to get more movement of the chlorine residual into all parts of the pipe network...to remove static water from slow-flow sections, deadends and stratified water in storage tanks on \_\_\_\_\_."

- A. Source water treatment
- B. Release of dangerous disinfection by-products
- C. Sample sites during routine monitoring
- D. A periodic basis
- E. None of the Above

381. Effecting repairs and replacement of \_\_\_\_\_ (e.g., broken mains and service meters) in a sanitary manner (i.e., soil-free replacement parts, disinfection and flushing of repaired lines, valves and fittings);

- A. Source water treatment
- B. Release of dangerous disinfection by-products
- C. Sample sites during routine monitoring
- D. Source waters
- E. None of the Above

382. Preventing pathogens from being drawn into the distribution system by \_\_\_\_\_ and preserving barriers between public water supplies and sewage or storm water drainage;

- A. Source water treatment
- B. Release of dangerous disinfection by-products
- C. Sample sites during routine monitoring
- D. Maintaining continuous positive pressure
- E. None of the Above

383. Varying the \_\_\_\_\_ to produce data more representative of the entire system.

- A. Source water treatment
- B. Release of dangerous disinfection by-products
- C. Sample sites during routine monitoring
- D. Source waters
- E. None of the Above

384. While the importance of source water treatment to \_\_\_\_\_ seems obvious, the need to devote equal effort to pathogen reduction in wastewater is not always recognized.

- A. Ensure safe drinking water
- B. Release of dangerous disinfection by-products
- C. Sample sites during routine monitoring
- D. Source waters
- E. None of the Above

385. The release of untreated or inadequately treated wastewater into source waters drawn upon by other communities presents a \_\_\_\_\_. Source waters heavily loaded with disease causing microorganisms can reduce the effectiveness of "downstream" drinking water treatment processes.

- A. Source water treatment
- B. Release of dangerous disinfection by-products
- C. Sample sites during routine monitoring
- D. Significant health risk
- E. None of the Above

386. Such advances as ultraviolet light disinfection systems, initially investigated as a wastewater disinfection option several years ago, are presently becoming more widely accepted and reliable with recent design enhancements. This technology has been demonstrated to be capable of \_\_\_\_\_ without the release of dangerous disinfection by-products.

- A. Source water treatment
- B. Release of dangerous disinfection by-products
- C. Sample sites during routine monitoring
- D. Meeting existing disinfection criteria
- E. None of the Above

### **Safe Drinking Water Act (SDWA)**

387. In 1974, Congress passed the Safe Drinking Water Act (SDWA) setting up a regulatory program among local, state, and federal agencies to \_\_\_\_\_.

- A. Develop Wellhead Protection Programs
- B. Provide public notification of contamination problems
- C. Help ensure the provision of safe drinking water in the U.S
- D. Requiring monitoring
- E. None of the Above

388. The states are expected to administer and \_\_\_\_\_ for public water systems (systems that either have 15 or more service connections or regularly serve an average of 25 or more people daily for at least 60 days each year).

- A. Set numerical standards
- B. Develop procedures
- C. Set treatment requirements
- D. Site-specific criteria are not met
- E. None of the Above

389. Public water systems \_\_\_\_\_, ensure proper drinking water quality through monitoring, and provide public notification of contamination problems.

- A. Develop Wellhead Protection Programs
- B. Provide public notification of contamination problems
- C. Safe drinking water in the U.S
- D. Must provide water treatment
- E. None of the Above

390. Relating to prevention of waterborne disease, the SDWA required EPA to: \_\_\_\_\_, referred to as Maximum Contaminant Levels (MCLs — the highest allowable contaminant concentrations in drinking water) or treatment technique requirements for contaminants in public water supplies.

- A. Set numerical standards
- B. Develop procedures
- C. Set treatment requirements
- D. Site-specific criteria are not met
- E. None of the Above

391. Issue regulations \_\_\_\_\_ of all regulated and certain unregulated contaminants, depending on the number of people served by the system, the source of the water supply, and the contaminants likely to be found;

- A. Develop Wellhead Protection Programs
- B. Provide public notification of contamination problems
- C. Safe drinking water in the U.S
- D. Requiring monitoring
- E. None of the Above

392. Set criteria under which systems are obligated to filter water from surface water sources; it must also develop procedures for states to determine which systems have to filter;

- A. Set numerical standards
- B. Develop procedures
- C. Set treatment requirements
- D. Site-specific criteria are not met
- E. None of the Above

393. Develop disinfection rules for all public water supplies; and require all states to develop Wellhead Protection Programs \_\_\_\_\_ that supply public drinking water systems.

- A. Develop Wellhead Protection Programs
- B. Provide public notification of contamination problems
- C. Designed to protect from sources of contamination areas around wells
- D. Requiring monitoring
- E. None of the Above

394. Through the Surface Water Treatment Rule (SWTR), EPA has \_\_\_\_\_ to control microbiological contaminants in public water systems using surface water sources (and ground-water sources under the direct influence of surface water).

- A. Set numerical standards
- B. Develop procedures
- C. Set treatment requirements
- D. Site-specific criteria are not met
- E. None of the Above

395. These requirements include the following: treatment must remove or \_\_\_\_\_ of Giardia lamblia cysts and 99.99% of viruses.

- A. Develop Wellhead Protection Programs
- B. Provide public notification of contamination problems
- C. Safe drinking water in the U.S
- D. Requiring monitoring
- E. None of the Above

396. All systems must disinfect, and are required to filter if certain source water quality criteria and \_\_\_\_\_.

- A. Set numerical standards
- B. Develop procedures
- C. Set treatment requirements
- D. Site-specific criteria are not met
- E. None of the Above

397. The \_\_\_\_\_ for determining if treatment, including turbidity (suspended particulate matter) removal and disinfection requirements, is adequate for filtered systems; and all systems must be operated by qualified operators as determined by the states.

- A. Set numerical standards
- B. Develop procedures
- C. Regulations set criteria
- D. Site-specific criteria are not met
- E. None of the Above

### **Current EPA Research –Barriers to Contamination**

398. Although water treatment and disinfection techniques are quite effective at \_\_\_\_\_, finished drinking water is not sterile.

- A. Water treatment and disinfection techniques
- B. Microbe reduction
- C. Organic compounds as carbon and energy sources
- D. Suspended solids
- E. None of the Above

399. Survival and regrowth of microorganisms in drinking water distribution systems can lead to the \_\_\_\_\_ and even noncompliance of a supply.

- A. Deterioration of water quality
- B. Drinking water distribution systems
- C. Organic compounds as carbon and energy sources
- D. Suspended solids
- E. None of the Above

400. Regrowth has largely been associated with \_\_\_\_\_ (i.e., those bacteria – including pathogens – that require preformed organic compounds as carbon and energy sources).

- A. Water treatment and disinfection techniques
- B. Heterotrophic bacteria
- C. Organic compounds as carbon and energy sources
- D. Suspended solids
- E. None of the Above

401. Bacterial growth occurs on the walls of the \_\_\_\_\_ (referred to as “biofilms”) and in the water either as free living cells or cells attached to suspended solids.

- A. Water treatment and disinfection techniques
- B. Drinking water distribution systems
- C. Distribution system
- D. None of the Above

402. A \_\_\_\_\_, bacterial regrowth is influenced primarily by temperature, residence time in mains and storage units, the efficacy of disinfection, and nutrients.
- A. Water treatment and disinfection techniques
  - B. Drinking water distribution systems
  - C. Organic compounds as carbon and energy sources
  - D. Multi-faceted phenomenon
  - E. None of the Above

### **Assimilable Organic Carbon (AOC)**

403. Assimilable organic carbon (AOC) is the portion of the total organic carbon (TOC) dissolved in water that is easily used by microorganisms as a \_\_\_\_\_(i.e., nutrients).

- A. Bacterial communities
- B. Bacteria, viruses and protozoan cysts
- C. Microorganisms
- D. Carbon source
- E. None of the Above

404. Researchers are currently investigating treatment processes to control AOC. One promising process is biologically active filtration wherein bacterial communities are intentionally established in the filters to use up, or biodegrade, the AOC as it passes through. This treatment process must be employed before final disinfection so that \_\_\_\_\_from the filter can be properly controlled.

- A. Bacterial communities
- B. Bacteria, viruses and protozoan cysts
- C. Microorganisms
- D. Bacteria escaping
- E. None of the Above

405. Most water utilities do not disinfect with chlorine until late in the treatment train. This limits the formation of \_\_\_\_\_(i.e., those compounds like chloroform produced when chlorine reacts with naturally occurring organic carbon).

- A. Bacterial communities
- B. Disinfection by-products
- C. Microorganisms
- D. Naturally occurring organic carbon
- E. None of the Above

406. To accomplish disinfection earlier in treatment, some water utilities employ ozonation. While ozone is a \_\_\_\_\_, it also converts a portion of the TOC into AOC.

- A. Bacterial communities
- B. Bacteria, viruses and protozoan cysts
- C. Microorganisms
- D. Very strong disinfectant
- E. None of the Above

407. Researchers are examining the advantages (e.g., disinfection of bacteria, viruses and protozoan cysts, control of color, control of taste and odor, \_\_\_\_\_, and partial oxidation of the naturally occurring organic carbon that reacts with chlorine) and disadvantages of ozone (e.g., enhancement of AOC, conversion of bromide to bromate, and formation of its own disinfection byproducts like formaldehyde).

- A. Bacterial communities
- B. Bacteria, viruses and protozoan cysts
- C. Microorganisms
- D. Naturally occurring organic carbon
- E. None of the Above

## Microorganisms Associated with Waterborne Disease

The following groups of microorganisms have been linked with the occurrence of waterborne disease. As each pathogen is isolated and identified as a threat to water quality, researchers try to discover the most effective combination of barriers and disinfection methods to minimize risk of human exposure.

408. Bacteria. Bacteria are the most widely distributed life forms. \_\_\_\_\_ range in length from approximately 0.4 to 14  $\mu\text{m}$  (a  $\mu\text{m}$  or “micrometer” equals one one-thousandth of a millimeter) and 0.2 to

1.2  $\mu\text{m}$  in width.

- A. Pathogenic bacteria
- B. Waterborne disease
- C. Key bacterial pathogens
- D. Bacteria and viruses
- E. None of the Above

409. Key bacterial pathogens responsible for \_\_\_\_\_ include Legionella, Salmonella typhi, Shigella, and Vibrio cholerae.

- A. Pathogenic bacteria
- B. Waterborne disease
- C. Key bacterial pathogens
- D. Bacteria and viruses
- E. None of the Above

410. Viruses. Viruses are inactive when outside of a living host cell. Viruses linked to waterborne disease have protein coats that provide protection from \_\_\_\_\_ and range in size from 0.02 to 0.09  $\mu\text{m}$ .

- A. Pathogenic bacteria
- B. Waterborne disease
- C. Environmental hazards
- D. Bacteria and viruses
- E. None of the Above

411. Unlike bacteria and protozoa, they contain only one type of nucleic acid (RNA or DNA). Key pathogens include \_\_\_\_\_.

- A. Pathogenic bacteria
- B. Hepatitis A and Norwalk virus
- C. Key bacterial pathogens
- D. Bacteria and viruses
- E. None of the Above

412. Protozoa. Protozoa, common in bodies of water, are much larger than bacteria and viruses. To survive harsh environmental conditions, some species can secrete a protective covering and form a resting stage called a “\_\_\_\_\_.”

- A. Pathogenic bacteria
- B. Waterborne disease
- C. Cyst
- D. Bacteria and viruses
- E. None of the Above

413. Encystment can protect protozoa from drinking water disinfection efforts and facilitate the spread of disease. Key protozoa being studied as agents of waterborne disease include \_\_\_\_\_ and Cryptosporidium.

- A. Pathogenic bacteria
- B. Waterborne disease
- C. Giardia
- D. Bacteria and viruses
- E. None of the Above

#### **Protozoan Diseases**

414. Two protozoans in the news today are Giardia and Cryptosporidium. Their consumption can lead to severe problems of the digestive system, which can be life-threatening to the very young, very old, or those with\_\_\_\_\_.

- A. Pathogenic bacteria
- B. Damaged immune systems
- C. Key bacterial pathogens
- D. Bacteria and viruses
- E. None of the Above

### **Current EPA Research —Bacteria**

415. The new National Primary Drinking Water Regulations require that all drinking water samples testing positive for total coliforms be further tested for the presence of either\_\_\_\_\_.

- A. Fecal E.coli
- B. Chlorine-stressed E. coli
- C. Fecal coliforms or E. coli
- D. The variant
- E. None of the Above

416. There is a method currently available that allows the simultaneous detection of \_\_\_\_\_ in a broth medium in 24 hours; however, there is no equivalent method for use with membrane filters. Development of such a method will allow those who prefer to obtain counts of these organisms in their distribution systems to use a membrane filter method and to have results within the 24-hour time frame.

- A. E. coli
- B. Fecal organisms
- C. Coliform-positive drinking water samples
- D. Total coliforms and E. coli
- E. None of the Above

417. Through the project "Development of a Membrane Filter Medium for the Simultaneous Detection of Total Coliforms and\_\_\_\_\_,", a membrane filter medium on which both total coliforms and E. coli can be distinguished from non-coliforms will be developed and patented.

- A. Fecal E.coli
- B. Chlorine-stressed E. coli
- C. E. coli
- D. The variant
- E. None of the Above

418. \_\_\_\_\_ are fecal organisms that when present in drinking water are indicative of fecal pollution. Logistical concerns in sample handling and holding require evaluation of conditions for optimizing sample stability and longevity.

- A. E. coli
- B. Fecal organisms
- C. Coliform-positive drinking water samples
- D. Vibrio cholerae
- E. None of the Above

419. No current regulations exist for handling samples for analysis of E. coli. Through the project entitled "Optimal Sample Holding Conditions for Analysis of Fecal E.coli in Drinking Water," sample temperature and holding time will be determined for E. coli or \_\_\_\_\_ (i.e., Colilert and M-FC agar).

- A. Fecal E.coli
- B. Chlorine-stressed E. coli
- C. Vibrio cholerae
- D. Fecal coliform analysis methods
- E. None of the Above

420. Relative recovery of methods and storage conditions will be assessed for optimal E. coli recovery. The requirement (through the SDWA amendments) to test all coliform-positive drinking water samples for either fecal coliforms or \_\_\_\_\_ is new.

- A. E. coli
- B. Fecal organisms
- C. Coliform-positive drinking water samples
- D. Vibrio cholerae
- E. None of the Above

421. Data from available methods for detecting chlorine damaged E. coli in drinking water are limited. The objective of the project entitled "Detection of Low Numbers of \_\_\_\_\_ in Drinking Water" is to evaluate and compare the abilities of a commercial method (Colilert) and a standard coliform method (ECMUG) to recover low numbers of chlorine-stressed E. coli from potable water.

- A. Fecal E.coli
- B. Chlorine-stressed E. coli
- C. Vibrio cholerae
- D. The variant
- E. None of the Above

422. Pure cultures of E. coli will be washed, nutrient-stressed in finished drinking water, and treated with chlorine. The chlorine-stressed \_\_\_\_\_ will then be enumerated, diluted to levels that would be found in marginally unsafe drinking water and assayed in multiple tubes by the three methods.

- A. E. coli
- B. Fecal organisms
- C. Coliform-positive drinking water samples
- D. Vibrio cholerae
- E. None of the Above

423. These experiments will be repeated using naturally occurring E. coli from diluted human fecal specimens, contaminated source waters and effluents. The infectious bacterial agent identified from the stools of cholera victims is \_\_\_\_\_. The epidemic in Latin America has prompted a renewed interest in control measures for this disease.

- A. Fecal E.coli
- B. Chlorine-stressed E. coli
- C. Vibrio cholerae
- D. The variant
- E. None of the Above

424. Through the project entitled "Inactivation of *Vibrio cholerae* Biotype \_\_\_\_\_ and Biotype Classical by Chlorination," it has been determined that the strain responsible for the epidemic in Peru is capable of reverting to a variant which is more resistant to chlorination than the typical smooth variety of *Vibrio cholerae*.

- A. El Tor
- B. Fecal organisms
- C. Coliform-positive drinking water samples
- D. *Vibrio cholerae*
- E. None of the Above

425. Cells of the variant appear to be imbedded in a gelatinous mucoid material, facilitating the formation of aggregates, which renders them more resistant to disinfection. Although \_\_\_\_\_ is more resistant, studies have indicated that all strains are readily inactivated through adequate chlorination.

- A. Fecal *E. coli*
- B. Chlorine-stressed *E. coli*
- C. *Vibrio cholerae*
- D. The variant
- E. None of the Above

426. The *Legionella pneumophila* bacterial strains that cause community- and hospital-acquired pneumonia are usually spread via finished drinking water. Certain free living amoebae (protozoa) support the multiplication of \_\_\_\_\_ in drinking water systems.

- A. *E. coli*
- B. Fecal organisms
- C. *L. pneumophila*
- D. *Vibrio cholerae*
- E. None of the Above

427. These amoebae may also be responsible for enhancing the virulence (capacity of a microorganism to cause disease) of the \_\_\_\_\_ and for protecting them from adverse environmental factors such as high temperature and chlorine disinfection.

- A. Fecal *E. coli*
- B. Chlorine-stressed *E. coli*
- C. *Vibrio cholerae*
- D. Legionellae
- E. None of the Above

428. Combinations of \_\_\_\_\_ isolates and specific amoebae that result in high yields of *Legionella* after intracellular growth will be used to study the effects of intracellular growth on virulence.

- A. *E. coli*
- B. Fecal organisms
- C. *Legionella*
- D. *Vibrio cholerae*
- E. None of the Above

429. Preliminary studies on the ability of \_\_\_\_\_ to supply iron to Legionellae growing intracellularly showed no obvious associations between growth and iron concentration. EPA is required by the SDWA to establish appropriate controls and regulations for potable water.

- A. Fecal *E. coli*
- B. Chlorine-stressed *E. coli*
- C. *Vibrio cholerae*
- D. Amoebae
- E. None of the Above

430. Although virulence is usually measured in vivo (animal research), the need for extensive animal testing can be significantly reduced by the development of a battery of in vitro (cell culture) tests for traits known to be \_\_\_\_\_. This battery can be used to predict the potential an organism has for causing disease in exposed populations.

- A. E. coli
- B. Virulence-related
- C. Virulence
- D. Vibrio cholerae
- E. None of the Above

## Fecal Pollution

431. Some believe that exposure to \_\_\_\_\_ through recreational waters or ingestion of contaminated shellfish causes greater health risks if the pollution is of human rather than animal origin.

- A. Global epidemiology
- B. Fecal pollution
- C. Low infective doses
- D. Inactivate/remove pathogens
- E. None of the Above

432. Before the relative risks of human versus animal fecal pollution can be assessed, it is necessary to develop a \_\_\_\_\_ for distinguishing human from animal pollution.

- A. Microbiological method
- B. Optimal pathogen removal techniques
- C. Associated with water-borne illnesses
- D. Conventional methods
- E. None of the Above

433. Current methods detect fecal pollution but do not reveal the source. The objective of the project entitled "Method to Distinguish Non-Human Fecal Pollution from Human Fecal Pollution" is to develop a gene probe specific for E. coli that inhabit the human intestine for use as \_\_\_\_\_.

- A. An indicator of the presence of human fecal contamination in water
- B. Humans are the reservoir for this pathogen
- C. Low infective doses
- D. Inactivate/remove pathogens
- E. None of the Above

434. The probe will be field tested at several sites in which \_\_\_\_\_ is exclusively from human sources, exclusively from animal sources and from mixed sources.

- A. Fecal pollution
- B. Optimal pathogen removal techniques
- C. Associated with water-borne illnesses
- D. Conventional methods
- E. None of the Above

## Shigella Species

435. Shigella species are among the most common and significant pathogens associated with wastewater and sludge. Because of their low infective doses, these organisms may be hazardous even if present in low numbers in wastewaters that are \_\_\_\_\_ or sludges that are applied to agricultural land.

- A. Global epidemiology
- B. Humans are the reservoir for this pathogen
- C. Recycled for potable use
- D. Inactivate/remove pathogens
- E. None of the Above

436. Shigellae are very difficult to detect in \_\_\_\_\_ because of their biochemical similarities to E. coli.
- A. Halogenation of water
  - B. Optimal pathogen removal techniques
  - C. Associated with water-borne illnesses
  - D. Environmental samples by conventional methods
  - E. None of the Above

## Conclusion

437. \_\_\_\_\_ constitute a major health hazard in both developed and developing nations. A new dimension to the global epidemiology of cholera-an ancient scourge-was provided by the emergence of *Vibrio cholerae* O139. Also, water-borne enterohaemorrhagic *Escherichia coli* (*E. coli* O157:H7), although regarded as a problem of the industrialized west, has recently caused outbreaks in Africa.

- A. Emerging waterborne pathogens
- B. Humans are the reservoir for this pathogen
- C. Low infective doses
- D. Inactivate/remove pathogens
- E. None of the Above

438. Outbreaks of \_\_\_\_\_ have motivated water authorities to reassess the adequacy of current water-quality regulations. Of late, a host of other organisms, such as hepatitis viruses (including hepatitis E virus), *Campylobacter jejuni*, microsporidia, cyclospora, *Yersinia enterocolitica*, calciviruses and environmental bacteria like *Mycobacterium* spp, aeromonads, *Legionella pneumophila* and multidrug-resistant *Pseudomonas aeruginosa* have been associated with water-borne illnesses.

- A. Halogenation of water
- B. Optimal pathogen removal techniques
- C. Associated with water-borne illnesses
- D. Conventional methods
- E. None of the Above

439. The protection and enhancement of our nation's water quality remains a chief concern of the U.S. Environmental Protection Agency. The Office of Research and Development is committed, through the extensive waterborne disease research efforts earlier described, to ensure that the most effective and efficient methods are developed to identify, detect, and \_\_\_\_\_ that may be present in our drinking water supplies.

- A. Global epidemiology
- B. Humans are the reservoir for this pathogen
- C. Low infective doses
- D. Inactivate/remove pathogens
- E. None of the Above

440. Life cycles, mechanisms of infection, protective or dormant states, emergence of disinfection resistant variants, optimal pathogen removal techniques, regrowth in distribution lines...all are areas that must be investigated and understood to afford the \_\_\_\_\_ that are so often taken for granted. The successes and failures of these research efforts, relayed to the public and appropriate federal, state, and local agencies, have helped to ensure safe drinking water.

- A. Halogenation of water
- B. Optimal pathogen removal techniques
- C. Water quality safeguards
- D. Conventional methods
- E. None of the Above

### **Salmonella Typhi**

441. Salmonella typhi, the basics. It's a bacteria. It causes diarrheal illness, also known as typhoid fever. And \_\_\_\_\_.

- A. Global epidemiology
- B. Humans are the reservoir for this pathogen
- C. Low infective doses
- D. Inactivate/remove pathogens
- E. None of the Above

442. Prevention strategies for this pathogen include \_\_\_\_\_, halogenation of water, and boiling water for one minute.

- A. Halogenation of water
- B. Optimal pathogen removal techniques
- C. Source protection
- D. Conventional methods
- E. None of the Above

### **Shigella Species**

443. Shigella species, the basics. It's a bacteria. It causes diarrheal illness known as shigellosis. Humans and primates are the reservoir for this pathogen. Shigella species, in the United States two-thirds of the shigellosis in the U.S. is caused by Shigella sonnei, and the remaining one-third is caused by Shigella flexneri. In developing countries, Shigella dysenteriae is the \_\_\_\_\_.

- A. Primary cause of illness associated with this pathogen
- B. Humans are the reservoir for this pathogen
- C. Low infective doses
- D. Inactivate/remove pathogens
- E. None of the Above

### **Campylobacter**

444. Campylobacter, the basics. It's a bacteria. It causes diarrheal illness. And Campylobacter is primarily associated with \_\_\_\_\_.

- A. Halogenation of water
- B. Optimal pathogen removal techniques
- C. Associated with water-borne illnesses
- D. Poultry, animals, and humans
- E. None of the Above

445. Campylobacter prevention. Prevention strategies for this pathogen include \_\_\_\_\_, halogenation of water, and boiling water for one minute.

- A. Source protection
- B. Humans are the reservoir for this pathogen
- C. Low infective doses
- D. Inactivate/remove pathogens
- E. None of the Above

### **Vibrio Cholerae**

446. Vibrio cholerae, the basics. It's a bacteria. It causes diarrheal illness, also known as cholera. It is typically associated with \_\_\_\_\_, shell stocks, and human.

- A. Halogenation of water
- B. Optimal pathogen removal techniques
- C. Associated with water-borne illnesses
- D. Aquatic environments
- E. None of the Above

### **Legionella**

447. Legionella, the basics. It's a bacteria. It causes a respiratory illness known as legionellosis. There are two illnesses associated with legionellosis: the first, Legionnaire's disease, which causes a severe pneumonia, and the second, Pontiac fever, which is a \_\_\_\_\_; it's typically an influenza-like illness, and it's less severe.

- A. Proliferation of Legionella
- B. Preventing Pseudomonas
- C. Non-pneumonia illness
- D. Pathogen
- E. None of the Above

448. Legionella is naturally found in water, both natural and artificial water sources. Legionella prevention. Maintaining hot water systems at or above 50 degrees Centigrade and cold water below 20 degrees Centigrade can prevent or control the \_\_\_\_\_ in water systems. Hot water in tanks should be maintained between 71 and 77 degrees Centigrade.

- A. Proliferation of Legionella
- B. Preventing Pseudomonas
- C. Reservoir for Hepatitis A virus
- D. Pathogen
- E. None of the Above

449. Proper recreational water system maintenance and disinfection can prevent the proliferation of Legionella in recreational water systems. It is important to prevent water stagnation. This can be accomplished by eliminating dead ends in distribution systems and in recreational water systems. Additionally, preventing biofilm development is important to control this \_\_\_\_\_ in water systems.

- A. Proliferation of Legionella
- B. Preventing Pseudomonas
- C. Reservoir for Hepatitis A virus
- D. Particular pathogen
- E. None of the Above

### **Pseudomonas**

450. Pseudomonas, the basics. It's a bacteria. It is caused by dermal contact with water. It can cause \_\_\_\_\_, which is an inflammation of the skin, or it can cause otitis, which is an infection of the ear. Pseudomonas is typically associated with soil and water.

- A. Proliferation of Legionella
- B. Preventing Pseudomonas
- C. Reservoir for Hepatitis A virus
- D. Dermatitis
- E. None of the Above

451. Pseudomonas, prevention. Proper maintenance and disinfection of recreational water systems is important in \_\_\_\_\_.

- A. Proliferation of Legionella
- B. Preventing Pseudomonas
- C. Reservoir for Hepatitis A virus
- D. Pathogen
- E. None of the Above

### **Hepatitis A**

452. Hepatitis A, the basics. It's a virus. It causes inflammation of the liver. And the \_\_\_\_\_ is humans.

- A. Proliferation of Legionella
- B. Preventing Pseudomonas
- C. Reservoir for Hepatitis A virus
- D. Pathogen
- E. None of the Above

### **Hepatitis A, Prevention**

453. Prevention strategies for this pathogen include source protection and adequate disinfection. Fecal matter can protect \_\_\_\_\_ from chlorine.

- A. Proliferation of Legionella
- B. Preventing Pseudomonas
- C. Hepatitis A virus
- D. Pathogen
- E. None of the Above

454. Additionally, \_\_\_\_\_ is resistant to combined chlorines, so it is important to have an adequate free chlorine residual.

- A. Proliferation of Legionella
- B. Preventing Pseudomonas
- C. Hepatitis A virus
- D. Pathogen
- E. None of the Above

### **Norovirus**

455. Norovirus, the basics. It's a virus. It causes diarrheal illness. And \_\_\_\_\_. Norovirus, prevention. Prevention strategies for this pathogen include source protection.

- A. Proliferation of Legionella
- B. Humans are the reservoir for this virus
- C. Reservoir for Hepatitis A virus
- D. Pathogen
- E. None of the Above

### **Cryptosporidium**

456. Cryptosporidium, the basics. It's a \_\_\_\_\_. It causes diarrheal illness known as cryptosporidiosis. It 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. Legionella
- B. Parasite
- C. Cryptosporidiosis
- D. Giardiasis
- E. None of the Above

457. Cryptosporidium, prevention. Prevention strategies for this \_\_\_\_\_ include source protection. A CT value of 9,600 is required when dealing with fecally accidents. CT equals a concentration, in parts per million, while time equals a contact time in minutes.

- A. Legionella
- B. Pathogen
- C. Cryptosporidiosis
- D. Giardiasis
- E. None of the Above

458. Cryptosporidium can also be prevented or eliminated by boiling water for one minute. Filtration with an "absolute" pore size of one micron or smaller can eliminate\_\_\_\_\_. And reverse osmosis is known to be effective as well.

- A. Cryptosporidium
- B. Pseudomonas
- C. Cryptosporidiosis
- D. Giardiasis
- E. None of the Above

### **Giardia**

459. Giardia, the basics. It is a parasite. It causes diarrheal illness known as \_\_\_\_\_. It is typically associated with water. It is the most common pathogen in waterborne outbreaks. It can also be found in soil and food. And humans and animals are the reservoir for this pathogen.

- A. Legionella
- B. Pseudomonas
- C. Cryptosporidiosis
- D. Giardiasis
- E. None of the Above

460. Giardia, prevention. Prevention strategies for this \_\_\_\_\_ include source protection; filtration, coagulation, and halogenation of drinking water.

- A. Dermatitis
- B. Pathogen
- C. An antihelmetic drug
- D. Giardiasis
- E. None of the Above

### **Schistosomatidae**

461. Schistosomatidae, the basics. It is a parasite. It is acquired through dermal contact, cercarial \_\_\_\_\_. It is commonly known as swimmer's itch.

- A. Dermatitis
- B. Pathogen
- C. An antihelmetic drug
- D. Giardiasis
- E. None of the Above

462. The reservoir for this pathogen are aquatic snails and birds. Schistosomatidae, prevention. Prevention strategies for this \_\_\_\_\_ include eliminating snails with a molluscicide or interrupting the life cycle of the parasite by treating birds with an antihelmetic drug.

- A. Dermatitis
- B. Pathogen
- C. An antihelmetic drug
- D. Giardiasis
- E. None of the Above

## **Disinfection Rules**

463. In the past 25 years, the Safe Drinking Water Act (SDWA) has been highly effective in protecting public health and has also evolved to respond to new and emerging threats to safe drinking water. \_\_\_\_\_ is one of the major public health advances in the 20th century.

- A. Carbon-containing compounds
- B. Organism destruction
- C. Chlorine oxidizes compounds
- D. Disinfection of drinking water
- E. None of the Above

464. One hundred years ago, typhoid and cholera epidemics were common through American cities; \_\_\_\_\_ was a major factor in reducing these epidemics.

- A. Disinfection
- B. Organic matter
- C. Chlorine-based compounds
- D. Public water supplies
- E. None of the Above

465. However, the disinfectants themselves can react with naturally-occurring materials in the water to form unintended byproducts which may pose health risks. In addition, in the past ten years, we have learned that there are \_\_\_\_\_, such as Cryptosporidium, which can cause illness and is resistant to traditional disinfection practices.

- A. Carbon-containing compounds
- B. Organism destruction
- C. Specific microbial pathogens
- D. Naturally-occurring materials
- E. None of the Above

466. \_\_\_\_\_ is the most widely used water disinfectant due to its effectiveness and cost. Using chlorine as a drinking water disinfectant has prevented millions of water borne diseases, such as typhoid, cholera, dysentery, and diarrhea.

- A. Chlorine
- B. Organic matter
- C. Chlorine-based compounds
- D. Public water supplies
- E. None of the Above

467. Most states require community water systems to use chlorination. However, research shows that chlorine has side effects. It reacts with \_\_\_\_\_ and forms a series of compounds that have been linked to cancer in animals.

- A. Carbon
- B. Organic matter present in water
- C. Chlorine-based compounds
- D. Public water supplies
- E. None of the Above

468. These compounds are called disinfection by-products (DBPs). All disinfectants form DBPs in one of two reactions: Chlorine and chlorine-based compounds (halogens) react with \_\_\_\_\_ in water causing the chlorine atom to substitute other atoms resulting in halogenated by-products and

- A. Carbon
- B. Organic matter
- C. Chlorine-based compounds
- D. Organics
- E. None of the Above

469. Oxidation reactions, where chlorine oxidizes compounds present in water. \_\_\_\_\_ are also formed when multiple disinfectants are used.

- A. Carbon-containing compounds
- B. Secondary by-products
- C. Chlorine oxidizes compounds
- D. Naturally-occurring materials
- E. None of the Above

470. All living organisms have carbon as an essential element in their cells. When trees shed their leaves, they start decomposing and are ultimately broken down by bacteria into\_\_\_\_\_.

- A. Carbon
- B. Organic matter
- C. Chlorine-based compounds
- D. Carbon-containing compounds
- E. None of the Above

471. Similarly, dead animals on land and fish and other aquatic life decompose and disintegrate into compounds that contain carbon as an essential element. Hence, all surface water and groundwater contain varying amounts of carbon-containing compounds called \_\_\_\_\_(primarily humic and fulvic acids).

- A. Carbon-containing compounds
- B. Organism destruction
- C. Organic matter
- D. Naturally-occurring materials
- E. None of the Above

472. The \_\_\_\_\_requires systems using public water supplies from either surface water or groundwater under the direct influence of surface water to disinfect.

- A. Carbon
- B. Organic matter
- C. Chlorine-based compounds
- D. Public water supplies
- E. None of the Above

473. Also, since some disinfectants produce\_\_\_\_\_, the dual objective of disinfection is to provide the required level of organism destruction and remain within the maximum contaminant level (MCL) for the SWTR disinfection set by EPA.

- A. Carbon-containing compounds
- B. Chemical by-products
- C. Chlorine oxidizes compounds
- D. Naturally-occurring materials
- E. None of the Above

474. The Disinfectants and Disinfection Byproducts (DBP) rules apply to all community and non-community water systems using a disinfectant such as\_\_\_\_\_.

- A. Chlorine, chloramines, ozone and chlorine dioxide
- B. Organic matter
- C. Chlorine-based compounds
- D. Public water supplies
- E. None of the Above

475. The Long Term 2 Enhanced Surface Water Treatment Rule (LT2) rule applies to all water systems using surface water, groundwater under the influence of a surface water, as well as groundwater/surface water blends. The LT2 requirements began in 2006 with the characterization of \_\_\_\_\_and E.coli levels. Systems serving <10,000 monitor for E.coli only every two weeks for one year. Compliance with the LT2 requirements begin in April 2013.

- A. Carbon-containing compounds
- B. Raw water Cryptosporidium
- C. Chlorine oxidizes compounds
- D. Naturally-occurring materials
- E. None of the Above

476. The Groundwater Rule (GWR) applies to all public water systems using groundwater. The GWR requirements begin in March 2009 with 6-months investigative monitoring (IM) for \_\_\_\_\_, for systems currently applying disinfection only. All other requirements for the GWR began back in Dec 2009.

- A. Bromodichloromethane, bromoform, chloroform, dichloroacetic acid, and bromate
- B. DBPs
- C. Total trihalomethanes
- D. Source water E.coli
- E. None of the Above

477. Amendments to the \_\_\_\_\_ in 1996 require EPA to develop rules to balance the risks between microbial pathogens and disinfection byproducts (DBPs). It is important to strengthen protection against microbial contaminants, especially Cryptosporidium, and at the same time, reduce potential health risks of DBPs.

- A. SDWA
- B. Microbial and Disinfection Byproducts Rules (MDBPs)
- C. Stage 2 DBPR
- D. Stage 1 Disinfectants and Disinfection Byproducts Rule
- E. None of the Above

478. The Stage 1 Disinfectants and Disinfection Byproducts Rule and Interim Enhanced Surface Water Treatment Rule, announced in December 1998, are the first of a \_\_\_\_\_ under the 1996 SDWA Amendments.

- A. Bromodichloromethane, bromoform, chloroform, dichloroacetic acid, and bromate
- B. DBPs
- C. Total trihalomethanes
- D. Primary or residual disinfectant other than UV
- E. None of the Above

### **Public Health Concerns**

479. While \_\_\_\_\_ are effective in controlling many microorganisms, they react with natural organic and inorganic matter in source water and distribution systems to form DBPs. Results from toxicology studies have shown several DBPs (e.g., bromodichloromethane, bromoform, chloroform, dichloroacetic acid, and bromate) to be carcinogenic in laboratory animals. Other DBPs (e.g., chlorite, bromodichloromethane, and certain haloacetic acids) have also been shown to cause adverse reproductive or developmental effects in laboratory animals.

- A. SDWA
- B. Microbial and Disinfection Byproducts Rules (MDBPs)
- C. Stage 2 DBPR
- D. Stage 1 Disinfectants and Disinfection Byproducts Rule
- E. None of the Above

480. Several epidemiology studies have suggested a weak association between certain cancers (e.g., bladder) or reproductive and developmental effects, and exposure to chlorinated surface water. More than 200 million people consume water that has been disinfected. Because of the large population exposed, health risks associated with \_\_\_\_\_, even if small, need to be taken seriously.

- A. Bromodichloromethane, bromoform, chloroform, dichloroacetic acid, and bromate
- B. DBPs
- C. Total trihalomethanes
- D. Primary or residual disinfectant other than UV
- E. None of the Above

### Who Must Comply With The Rule?

481. The \_\_\_\_\_ applies to all community and nontransient non-community water systems that treat their water with a chemical disinfectant for either primary or residual treatment.

- A. SDWA
- B. Microbial and Disinfection Byproducts Rules (MDBPs)
- C. Stage 2 DBPR
- D. Stage 1 Disinfectants and Disinfection Byproducts Rule
- E. None of the Above

### What Does The Rule Require?

482. The Stage 1 Disinfectant and Disinfection Byproduct Rule updates and supersedes the 1979 regulations for \_\_\_\_\_. In addition, it will reduce exposure to three disinfectants and many disinfection byproducts.

- A. Bromodichloromethane, bromoform, chloroform, dichloroacetic acid, and bromate
- B. DBPs
- C. Total trihalomethanes
- D. Primary or residual disinfectant other than UV
- E. None of the Above

## Stage 2 DBP Rule Federal Register Notices

483. The \_\_\_\_\_ rule is one part of the Microbial and Disinfection Byproducts Rules (MDBPs), which are a set of interrelated regulations that address risks from microbial pathogens and disinfectants/disinfection byproducts.

- A. SDWA
- B. Microbial and Disinfection Byproducts Rules (MDBPs)
- C. Stage 2 DBP
- D. Stage 1 Disinfectants and Disinfection Byproducts Rule
- E. None of the Above

484. The \_\_\_\_\_ rule focuses on public health protection by limiting exposure to DBPs, specifically total trihalomethanes (TTHM) and five haloacetic acids (HAA5), which can form in water through disinfectants used to control microbial pathogens.

- A. SDWA
- B. Microbial and Disinfection Byproducts Rules (MDBPs)
- C. Stage 2 DBP
- D. Stage 1 Disinfectants and Disinfection Byproducts Rule
- E. None of the Above

485. This rule will apply to all community water systems and nontransient non-community water systems that add a primary or residual disinfectant other than ultraviolet (UV) light or deliver water that has been disinfected by a \_\_\_\_\_.

- A. Bromodichloromethane, bromoform, chloroform, dichloroacetic acid, and bromate
- B. DBPs
- C. Total trihalomethanes
- D. Primary or residual disinfectant other than UV
- E. None of the Above

486. In the past 30 years, the \_\_\_\_\_ has been highly effective in protecting public health and has also evolved to respond to new and emerging threats to safe drinking water. Disinfection of drinking water is one of the major public health advances in the 20th century.

- A. Safe Drinking Water Act (SDWA)
- B. Microbial and Disinfection Byproducts Rules (MDBPs)
- C. Stage 2 DBPR
- D. None of the Above

487. The disinfectants themselves can react with naturally-occurring materials in the water to form byproducts, which may pose health risks. In addition, in the past 10 years, we have learned that there are specific \_\_\_\_\_, such as Cryptosporidium, which can cause illness, and are highly resistant to traditional disinfection practices.

- A. Microbial pathogens
- B. DBPs
- C. Total trihalomethanes
- D. Primary or residual disinfectant other than UV
- E. None of the Above

488. Amendments to the \_\_\_\_\_ in 1996 require EPA to develop rules to balance the risks between microbial pathogens and disinfection byproducts (DBPs).

- A. SDWA
- B. Microbial and Disinfection Byproducts Rules (MDBPs)
- C. Stage 2 DBPR
- D. Stage 1 Disinfectants and Disinfection Byproducts Rule
- E. None of the Above

489. The \_\_\_\_\_ and Interim Enhanced Surface Water Treatment Rule, promulgated in December 1998, were the first phase in a rulemaking strategy required by Congress as part of the 1996 Amendments to the Safe Drinking Water Act.

- A. Bromodichloromethane, bromoform, chloroform, dichloroacetic acid, and bromate
- B. DBPs
- C. Total trihalomethanes
- D. Primary or residual disinfectant other than UV
- E. None of the Above

490. The \_\_\_\_\_ builds upon the Stage 1 DBPR to address higher risk public water systems for protection measures beyond those required for existing regulations.

- A. SDWA
- B. Microbial and Disinfection Byproducts Rules (MDBPs)
- C. Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 DBPR)
- D. Stage 1 Disinfectants and Disinfection Byproducts Rule
- E. None of the Above

491. The Stage 2 DBPR and the Long Term 2 Enhanced Surface Water Treatment Rule are the second phase of rules required by Congress. These rules strengthen protection against microbial contaminants, especially \_\_\_\_\_, and at the same time, reduce potential health risks of DBPs.

- A. Bromodichloromethane, bromoform, chloroform, dichloroacetic acid, and bromate
- B. DBPs
- C. Total trihalomethanes
- D. Cryptosporidium
- E. None of the Above

#### **What is the Stage 2 DBPR?**

492. The \_\_\_\_\_ will reduce potential cancer and reproductive and developmental health risks from disinfection byproducts (DBPs) in drinking water, which form when disinfectants are used to control microbial pathogens. Over 260 million individuals are exposed to DBPs.

- A. SDWA
- B. Microbial and Disinfection Byproducts Rules (MDBPs)
- C. Stage 2 Disinfection Byproducts Rule
- D. Stage 1 Disinfectants and Disinfection Byproducts Rule
- E. None of the Above

493. This final rule strengthens \_\_\_\_\_ for customers by tightening compliance monitoring requirements for two groups of DBPs, trihalomethanes (TTHM) and haloacetic acids (HAA5).

- A. SDWA
- B. Microbial and Disinfection Byproducts Rules (MDBPs)
- C. Stage 2 DBPR
- D. Public health protection
- E. None of the Above

494. The rule targets systems with the greatest risk and builds incrementally on existing rules. This regulation will reduce DBP exposure and related potential health risks and provide more equitable public health protection. The Stage 2 DBPR is being promulgated simultaneously with the \_\_\_\_\_ to address concerns about risk tradeoffs between pathogens and DBPs.

- A. SDWA
- B. Microbial and Disinfection Byproducts Rules (MDBPs)
- C. Stage 2 DBPR
- D. Long Term 2 Enhanced Surface Water Treatment Rule
- E. None of the Above

**What does the rule require?**

495. Under the Stage 2 DBPR, systems will conduct an evaluation of their distribution systems, known as an Initial Distribution System Evaluation (IDSE), to identify the locations with high disinfection byproduct concentrations. These locations will then be used by the systems as the \_\_\_\_\_ for Stage 2 DBPR compliance monitoring.

- A. DBP MCLs
- B. Sampling sites
- C. TTHM and HAA5
- D. Possible future MCL violations
- E. None of the Above

496. Compliance with the maximum contaminant levels for two groups of disinfection byproducts (TTHM and HAA5) will be calculated for each monitoring location in the distribution system. This approach, referred to as the \_\_\_\_\_, differs from current requirements, which determine compliance by calculating the running annual average of samples from all monitoring locations across the system.

- A. DBP MCLs
- B. Initial Distribution System Evaluation (IDSE)
- C. Locational running annual average (LRAA)
- D. Possible future MCL violations
- E. None of the Above

497. The \_\_\_\_\_ also requires each system to determine if they have exceeded an operational evaluation level, which is identified using their compliance monitoring results. The operational evaluation level provides an early warning of possible future MCL violations, which allows the system to take proactive steps to remain in compliance.

- A. DBP MCLs
- B. Stage 2 DBPR
- C. TTHM and HAA5
- D. Possible future MCL violations
- E. None of the Above

498. A system that exceeds an operational evaluation level is required to review their operational practices and submit a report to their state that identifies actions that may be taken to mitigate future high \_\_\_\_\_, particularly those that may jeopardize their compliance with the DBP MCLs.

- A. DBP levels
- B. Initial Distribution System Evaluation (IDSE)
- C. TTHM and HAA5
- D. None of the Above

**Who must comply with the rule?**

499. Entities potentially regulated by the Stage 2 DBPR are \_\_\_\_\_that produce and/or deliver water that is treated with a primary or residual disinfectant other than ultraviolet light.

- A. DBP MCLs
- B. Initial Distribution System Evaluation (IDSE)
- C. Community and nontransient noncommunity water systems
- D. Possible future MCL violations
- E. None of the Above

500. A community water system (CWS) is \_\_\_\_\_that serves year-round residents of a community, subdivision, or mobile home park that has at least 15 service connections or an average of at least 25 residents.

- A. A public water system
- B. Community water system (CWS)
- C. Small system
- D. Nontransient non-community water system (NTNCWS)
- E. None of the Above

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