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Wastewater Treatment _____ Other _____

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Please write down any questions that cannot be found or has problems

Please circle, underline, bold or X only one correct answer

A felt tippen pen works best.

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| 1. A B | 18. A B | 35. A B | 52. A B C D |
| 2. A B | 19. A B C D | 36. A B | 53. A B C D |
| 3. A B | 20. A B C D | 37. A B C D | 54. A B C D |
| 4. A B | 21. A B C D | 38. A B C D | 55. A B C D |
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| 96. A B C D | 128. A B | 160. A B C D | 192. A B C D |
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| 215. A B | 247. A B C D | 279. A B | 311. A B |
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| 336. A B | 355. A B | 374. A B C D | 393. A B C D |
| 337. A B C D | 356. A B | 375. A B C D | 394. A B C D |
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| 339. A B C D | 358. A B C D | 377. A B | 396. A B |
| 340. A B C D | 359. A B C D | 378. A B | 397. A B C D |
| 341. A B C D | 360. A B C D | 379. A B | 398. A B C D |
| 342. A B C D | 361. A B C D | 380. A B | 399. A B |
| 343. A B C D | 362. A B C D | 381. A B | 400. A B |

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WWT 202 CEU Course Assignment

The Assignment is available in Word on the Internet for your Convenience, please visit www.ABCTLC.com and download the assignment and email it back to TLC.

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

Multiple Choice, please select only one answer per question. There are no intentional trick questions.

1. NPDES permits are issued by states that have obtained EPA approval to issue permits or by EPA Regions in states without such approval.

A. True B. False

2. Federal laws provide authorized state regulatory agencies and the EPA with various methods of taking enforcement actions against violators of permit requirements.

A. True B. False

Establishing the Regulatory Authority Program

3. The two basic types of NPDES permits issued are zero discharge and commercial permits.

A. True B. False

Legal Authority

4. POTWs seeking pretreatment program approval must develop recommendations for program implementation and establish the taxation authority to implement and enforce program requirements.

A. True B. False

Requiring Industrial Users to Obtain Permits

5. Whether in a local sewer ordinance or state law, the legal authority for a permit system, must make it clear that Non-Users covered by the permit program must obtain a permit or be subject to control under some general control mechanism.

A. True B. False

Primary Wastewater Components and Constituents

6. Reduction is the addition of oxygen to an element or compound, or removal of hydrogen or an electron from an element or compound in a chemical reaction.

A. True B. False

7. Aerobic is a condition in which free or dissolved oxygen is present in the aquatic environment.

A. True B. False

8. Aerobic Bacteria will live and reproduce only in an environment containing oxygen.

A. True B. False

9. When oxygen chemically combined, such as in water molecules can be used for respiration by aerobes

- A. True B. False

10. Under anaerobic conditions in wastewater, sulfur compounds or elemental sulfur are reduced to H₂S or sulfide ions.

- A. True B. False

Basic Wastewater Treatment Processes

11. In wastewater treatment, particles with which of the following float to the top of water and can be removed?

- A. Inorganic material C. Entrapped air
B. Activated Sludge D. None of the Above

Biological

12. Bacteria and other small organisms in water consume organic matter in sewage, turning it into new bacterial cells, _____, and other by-products.

- A. Oxygen C. Secondary treatment
B. Carbon dioxide D. None of the Above

13. Which of the following wastewater terms means a suspended growth process for removing organic matter from sewage by saturating it with air and microorganisms that can break down the organic matter?

- A. Biosolid(s) C. Activated Sludge
B. Organic material D. None of the Above

14. Masses of microorganisms grow and rapidly metabolized organic pollutants because of the addition of which term to wastewater?

- A. MLVSS C. Oxygen
B. Carbon dioxide D. None of the Above

Organic Matter

15. One of the measurements used to assess overall wastewater strength, the amount of oxygen organisms needed to break down wastes in wastewater is referred to as?

- A. BOD C. COD
B. MLSS D. None of the Above

16. Some organic compounds are more stable than others are and cannot be quickly broken down by organisms; this is true of _____ developed for agriculture and industry.

- A. Most inorganic substances C. Organic material(s)
B. Many synthetic organic compounds D. None of the Above

17. Two toxic _____ like benzene and toluene are found in some solvents, pesticides, and other products.

- A. Nutrients from wastewater C. Organic compounds
B. Inorganic materials D. None of the Above

Oil and Grease

18. Fatty organic materials from animals, vegetables, and petroleum are quickly broken down by bacteria and can cause pollution in receiving environments.

- A. True B. False

19. Which of the following wastewater terms also adds to the septic tank scum layer, causing more frequent tank pumping to be required?

- A. Nutrients from wastewater
- B. Inorganic materials
- C. Excessive grease
- D. None of the Above

20. Which of the following wastewater terms used for motors and industry are considered hazardous waste and should be collected and disposed of separately from wastewater?

- A. Nitrogen and phosphorus
- B. Inorganic substances
- C. Petroleum-based waste oil(s)
- D. None of the Above

21. When large amounts of oils and greases are discharged, these increase _____ and they may float to the surface and harden, causing aesthetically unpleasing conditions.

- A. BOD
- B. COD
- C. Petroleum-based waste oil(s)
- D. None of the Above

Inorganics

22. According to the text, heavy metals can be discharged with many types of industrial wastewaters are easy to remove by conventional treatment methods.

- A. True
- B. False

Nutrients

23. Which of the following are essential to living organisms and are the chief nutrients present in natural water?

- A. Oxygen
- B. Carbon dioxide
- C. Carbon, nitrogen, and phosphorus
- D. Answers A,B and C

24. An excess of nutrients over-stimulates the growth of water plants, the result causes unsightly conditions, interferes with drinking water treatment processes, and causes unpleasant and disagreeable tastes and odors in drinking water.

- A. True
- B. False

25. Primarily _____ but occasionally nitrogen, causes nutrient enrichment which results in excessive growth of algae.

- A. Phosphorus
- B. Nitrifying Bacteria
- C. Ammonia
- D. Calcium Hydroxide

Inorganic and Synthetic Organic Chemicals

26. Inorganic and Synthetic Organic Chemicals can cause _____ problems, and many are not effectively removed by conventional wastewater treatment.

- A. Toxic
- B. Ecology
- C. Excessive growth of aerobic bacteria
- D. Taste and odor

Biological Components Section Introduction

Biochemical Oxygen Demand

27. The BOD test has merit as a pollution parameter continues to be debated, _____ has the advantage of a long period of record.

- A. BOD
- B. CBOD
- C. MLSS
- D. MLVSS

Application Specific Microbiology

28. Which of the following is the preferred methodology in wastewater treatment affecting the efficiency of biological nutrient removal?

- A. Attached growth
- B. Advanced treatment technologies
- C. Application-specific microbiology
- D. None of the Above

29. To reduce the start-up phase for growing a mature biofilm one can also purchase application-specific microbiology culture from appropriate microbiology vendors.

- A. True
- B. False

Primary Wastewater Treatment Section

Conventional A/S Wastewater Treatment Plant Overview

Primary Treatment

30. The secondary stage uses this term to further purify wastewater.

- A. Primary and secondary stages
- B. Biological processes
- C. Suspended growth process(es)
- D. None of the Above

31. Coarse solids are removed from the wastewater in the primary stage of treatment. In some treatment plants, _____ may be combined into one basic operation.

- A. Primary and secondary stages
- B. Biological processes
- C. Suspended growth process(es)
- D. None of the Above

32. There are two basic stages in the treatment of wastes, RAS and WAS.

- A. True
- B. False

33. The initial stage in the treatment of domestic wastewater is known as bar screens.

- A. True
- B. False

Preliminary Treatment

34. The Preliminary Treatment is purely physical stage consisting of Coarse Screening, Raw Influent Pumping, Static Fine Screening, Grit Removal, and Selector Tanks.

- A. True
- B. False

35. After the wastewater has been screened, it may flow into a grit chamber where sand, grit, cinders, and small stones settle to the bottom

- A. True
- B. False

36. In some plants, another finer screen is placed after the grit chamber to remove any additional material that might damage equipment or interfere with later processes.

- A. True
- B. False

37. Large amounts of _____ entering a treatment plant can cause serious operating problems, such as excessive wear of pumps and other equipment.

- A. Solid(s)
- B. Finer debris
- C. Grit and sand
- D. Dissolved organic and inorganic constituents

38. Which of the following enters from the collection system into the Coarse Screening process?

- A. Raw wastewater
- B. Biological processes
- C. Dissolved organic and inorganic constituents
- D. None of the Above

39. Especially in cities with combined sewer systems, removing the-this missing term-that washes off streets or land during storms is very important.

- A. Very fine solids
- B. Grit and gravel
- C. Primary sludge
- D. None of the Above

Primary Sedimentation

40. Pollutants that are dissolved or are very fine and remain suspended in the wastewater are easily removed effectively by gravity settling.

- A. True
- B. False

41. When the screening completed and the grit removed, wastewater is clear of dissolved organic and inorganic constituents along with suspended solids.

- A. True
- B. False

42. Which of the following wastewater treatment terms consist of minute particles of matter that can be removed from the wastewater with further treatment such as sedimentation or gravity settling, chemical coagulation, or filtration?

- A. Solid(s)
- B. Suspended solids
- C. Dissolved organic and inorganic constituents
- D. None of the Above

43. When the wastewater enters a sedimentation tank, it slows down and the suspended solids gradually sink to the bottom, this mass of solids is called?

- A. Very fine solids
- B. RAS
- C. Primary sludge
- D. Heavy pollutants

Temperature

44. The best temperatures for wastewater treatment probably range from 77 to 95 degrees Fahrenheit.

- A. True
- B. False

45. Hot water is a byproduct of many manufacturing processes, is not a pollutant. When discharged in large quantities, it can raise the temperature of receiving streams improving the natural balance of aquatic life.

- A. True
- B. False

pH

46. The acidity or alkalinity of wastewater affects both treatment and the environment.

- A. True
- B. False

47. pH indicates increasing acidity while a low pH indicates increasing alkalinity.

- A. True
- B. False

Secondary Treatment Section

Secondary Treatment

48. The wastewater enters from Preliminary Treatment into the clarifier process which is a biological process consisting of large oval shaped basins that are capable of removing these finer solids.

- A. True
- B. False

49. Maintaining a population of microorganisms within the oxidation basins that consumes _____ and also adhere to the solids themselves.

- A. Total Solids
- B. TDS
- C. Very fine solids
- D. None of the Above

50. Which of the following form larger and heavier aggregates that can be physically separated?

- A. Solid(s)
- B. Finer debris
- C. Finer solids
- D. None of the Above

51. The two most common conventional methods used to achieve secondary treatment are: _____ and suspended growth processes.

- A. Attached growth processes
- B. Finer debris
- C. Unsuspended growth process(es)
- D. None of the Above

52. The Secondary Treatment stage consists of a biological process such as _____ and a physical process, Secondary Clarification.

- A. Trickling filters
- B. Oxidation Ditches
- C. Phosphorus-reduction system(s)
- D. None of the Above

53. The Preliminary Treatment stage removes as much _____ as possible using physical processes.

- A. Solid(s)
- B. Finer debris
- C. Grit and gravel
- D. None of the Above

Raw Water Screening

54. Raw wastewater may or may not be _____ before being directed into the pond treatment system. The first two ponds in the pond system may be operated in series or in parallel.

- A. Screened and de-gritted
- B. Series or in parallel
- C. Compacted clay bottoms and sides
- D. None of the above

55. Generally, the microorganisms in the first ponds treat the incoming effluent, while the next pond is the settling or polishing pond. The third pond is to provide _____ where the biological solids generated in the first two ponds can settle.

- A. Wind and algae
- B. A quiet zone
- C. Activated sludge
- D. None of the above

56. Ponds generally do not have a secondary clarifier, the _____ fulfills the clarifier action.

- A. Wind and algae
- B. Series or in parallel
- C. Settling or polishing pond
- D. None of the above

Pond Lining

57. Ponds may be lined with a synthetic liner or simply have _____.

- A. Wind and algae
- B. Series or in parallel
- C. Compacted clay bottoms and sides
- D. None of the above

58. Many ponds rely on _____ to supply oxygen instead of mechanical aeration.

- A. Wind and algae
- B. Series or in parallel operation
- C. Compacted clay bottoms and sides
- D. None of the above

59. Filamentous bacteria generally do not cause any operational problems in lagoons, in contrast to activated sludge where _____ and poor sludge settling is a common problem.

- A. Redox potential
- B. Filamentous bulking
- C. BOD removal
- D. None of the Above

60. Most heterotrophic bacteria have a wide range in environmental tolerance and can function effectively in _____ over a wide range in pH and temperature.

- A. Redox potential
- B. Poor sludge settling
- C. BOD removal
- D. None of the Above

61. Aerobic BOD removal generally proceeds well from pH _____ and at temperatures from 3-4°C to 60-70°C (37.4 -39.2° F to 140-158°F in the ATAD process (mesophilic bacteria are replaced by thermophilic bacteria at temperatures above 35°C).

- A. 5.5 to 8.0
- B. 6.5 to 9.0
- C. 6.5 to 7.0
- D. None of the Above

62. BOD removal generally declines rapidly below _____ C and ceases at _____ C.

- A. 3-4° - 1-2°
- B. 4-6° - 2-3°
- C. 1-2° - 3-4°
- D. None of the Above

63. A very specialized group of bacteria occurs to some extent in lagoons (and other wastewater treatment systems) that can oxidize ammonia via nitrite to nitrate, termed nitrifying bacteria. These bacteria are strict aerobes and require a redox potential of at least _____ m V.

- A. +200
- B. - 200
- C. 2,000
- D. None of the Above

Lagoon Systems

64. Lagoon systems are shallow basins that hold the wastewater for several months to allow for the natural degradation of sewage.

- A. True
- B. False

65. Lagoon systems take advantage of _____ and microorganisms in the wastewater to renovate sewage.

- A. Nitrogen removal system(s)
- B. Suspended film system(s)
- C. Natural aeration
- D. None of the Above

Microorganisms in Lagoons

66. Predators feed mostly on stalked and _____.

- A. Floc-forming bacteria
- B. Swimming ciliates
- C. Methane Fermenters
- D. None of the Above

67. The following changes in food, dissolved oxygen, temperature, pH, total dissolved solids, sludge age, presence of toxins, and other factors create a dynamic environment for the _____?

- A. Treatment organism(s)
- B. Aerobic bacteria
- C. Floc-forming bacteria
- D. None of the Above

68. Food (organic loading) regulates _____?

- A. Strict aerobes
- B. Predators
- C. Microorganism numbers
- D. None of the Above

69. Swimming and _____ engulf bacteria or other prey.

- A. Gliding ciliates
- B. Predators
- C. Heterotrophic bacteria
- D. None of the Above

70. Which of the following bugs or terms attach to the biomass and vortex suspended bacteria into their gullets, while crawlers break bacteria loose from the floc surface?

- A. Floc-forming bacteria
- B. Aerobic bacteria
- C. Stalked ciliate(s)
- D. None of the Above

Lagoon Microorganisms Introduction

71. Which of the following are similar to those found in other treatment processes such as activated sludge?

- A. Treatment organism(s)
- B. Aerobic bacteria
- C. Floc-forming bacteria
- D. None of the Above

72. Which of the following degrade wastes grow as single bacteria dispersed in the wastewater?

- A. Strict aerobes
- B. Predators
- C. Many bacterial species
- D. None of the Above

73. Which of the following grow in a large aggregate due to exocellular polymer production?

- A. Predators
- B. Aerobic bacteria
- C. Floc-forming bacteria
- D. None of the Above

74. Growth form is important as these flocs degrade _____ and settle at the end of the process, producing a low TSS effluent.

- A. Anaerobic action
- B. Application-specific bacteria
- C. BOD
- D. None of the Above

75. Which of the following bugs or terms occur in lagoons, usually at specific growth environments?

- A. Anaerobic action
- B. Absence of free oxygen
- C. A number of filamentous bacteria
- D. None of the Above

76. Which of the following have a wide range in environmental tolerance and can function effectively in BOD removal over a wide range in pH and temperature?

- A. Strict aerobes
- B. Predators
- C. Most heterotrophic bacteria
- D. None of the Above

77. A very specialized group of bacteria occurs to some extent in lagoons (and other wastewater treatment systems) that can oxidize ammonia via nitrite to nitrate are termed?

- A. Strict aerobes
- B. Predators
- C. Nitrifying bacteria
- D. None of the Above

78. BOD removal increases rapidly below 3-4°C and ceases at 1-2°C.

- A. True
- B. False

79. Three bacteria groups occur: freely dispersed, single bacteria; floc-forming bacteria; and filamentous bacteria. All function similarly to oxidize organic carbon to produce CO₂ and new bacteria.

- A. True
- B. False

80. Anaerobic BOD removal generally proceeds well from pH 6.5 to 9.0 and at temperatures from 3-4°C to 60-70°C (Aerobic bacteria are replaced by Mesophilic bacteria at temperatures above 35°C).

- A. True
- B. False

Mixed or Suspended Lagoons

81. The aerated lagoons are basins, normally excavated in earth and operated without Solids recycling into the system. This is the major difference with respect to activated sludge systems.

- A. True B. False

82. Two types are the most common: The Aerobic-anaerobic or partially suspended lagoon in which the concentration of solids and dissolved oxygen are maintained fairly uniform and neither the incoming solids nor the biomass of microorganisms' settle, and the completely mixed lagoon.

- A. True B. False

83. In the facultative lagoons, the power input is reduced causing accumulation of solids in the bottom which undergo _____, while the upper portions are maintained aerobic.

- A. Facultative lagoon(s) C. Dissolved organic and inorganic constituents
B. Anaerobic decomposition D. None of the Above

Advanced Methods of Wastewater Treatment

84. As our country and the demand for clean water have grown, it has become more important to produce cleaner wastewater effluents, yet _____ are more difficult to remove than others.

- A. Biofilm C. Soluble nutrients
B. Some contaminants D. None of the Above

85. All WWTPs provide a minimum of?

- A. Biofilm and chemical removal C. Pretreatment and pollution prevention
B. Secondary treatment D. None of the Above

Advanced Treatment Technologies

86. WWTP treatment levels beyond secondary treatment are called advanced treatment.

- A. True B. False

87. Which of the following can be extensions of conventional secondary biological treatment to further stabilize oxygen-demanding substances?

- A. Hydraulic Detention Time C. Advanced treatment technologies
B. Activated sludge system D. None of the Above

88. Advanced treatment may include physical-chemical separation techniques such as adsorption, flocculation/precipitation, membranes for advanced filtration, _____, and reverse osmosis.

- A. Denitrification process C. Ion exchange
B. Organic material D. None of the Above

Activated Sludge Process Section

Regular MLSS Removal

89. To maintain a stable treatment process, MLSS must be removed on a regular schedule. The MLSS can be removed from the bottom of the clarifier or from the _____.

- A. Secondary sludge wasting C. Activated sludge basin
B. Solids handling process D. None of the above

90. The _____ removed directly from the basin is renamed as WAS.

- A. MLSS C. WAS
B. CRT D. None of the above

91. Some clarifiers have separate pipelines for RAS and WAS. In other cases, WAS is pumped out of the _____ pipeline.
- A. RAS C. WAS
B. CRT D. None of the above

Wasting Rates

92. The amount of _____ in the secondary system is controlled and maintained through solids wasting.
- A. Biomass (MLSS) C. WAS
B. CRT D. None of the above
93. In nearly all activated sludge plants, wasting is accomplished by directing a portion of the Return Sludge to the _____.
- A. Secondary sludge wasting C. Many activated sludge plants
B. Solids handling facility D. None of the above
94. CRT was defined as the average length of time in days that an organism remains in the _____.
- A. Secondary treatment system C. Many activated sludge plants
B. Solids handling process D. None of the above
95. The operator determines the operating _____ for the facility and maintains it through wasting the appropriate amount of excess biomass (Waste Activated Sludge, WAS) from the secondary system.
- A. Mixed Liquor C. WAS
B. CRT D. None of the above
96. Wasting Return Sludge rather than _____ minimizes the volume of water that must be processed by the sludge thickening/dewatering equipment.
- A. Mixed Liquor C. RAS
B. CRT D. None of the above
97. If intermittent wasting is practiced, it is usually best to waste over as long a time period as practical, and when the loading on the _____ is at the low point of the day.
- A. Secondary system C. Many activated sludge plants
B. Solids handling process D. None of the above
98. Drastic changes should not be made in wasting rates from one day to the next; allow the _____ time to acclimate to a change before another change is made.
- A. Secondary sludge wasting C. Advanced system
B. Biological system D. None of the above
99. Consistency is a key element in successful _____ operation.
- A. Secondary system C. Activated sludge plant
B. The operator D. None of the above
100. Many activated sludge plants were originally designed to waste secondary solids into the primary clarifiers. The reasoning was that as the less dense biological solids co-settle with the _____ the combined sludge density would be increased.
- A. Mixed Liquor C. Scum
B. Heavier primary solids D. None of the above

101. A more efficient operation will result if the WAS is wasted directly to a _____ and not allowed to return to the treatment system.

- A. Secondary sludge wasting
- B. Solids handling process
- C. Many activated sludge plants
- D. None of the above

102. It is crucial that adequate solids concentrating equipment and _____ are part of any plans for building or expanding an activated sludge plant.

- A. Secondary system
- B. The operator
- C. Solids storage capability
- D. None of the above

103. Which of the following is one of the most important controls available to the operator because it controls the most important aspect of treatment, biomass population?

- A. Secondary system
- B. Secondary sludge wasting
- C. Activated sludge plant
- D. None of the above

104. A good _____ control situation is one that allows the operator to set a totalizer which determines the maximum number of gallons wasted in a particular day and also allows the operator to control and monitor the WAS flow rate.

- A. MLSS concentration
- B. WAS
- C. BOD, nutrients, and oxygen
- D. None of the above

Environmental Conditions

105. Slower growing microorganisms, including the nitrification bacteria and some bacteria and some filaments, can only remain in the treatment process if the _____ is held long enough for them to reproduce.

- A. MLSS
- B. WAS
- C. BOD, nutrients, and oxygen
- D. None of the above

106. Waste activated sludge flow, along with environmental conditions such as water temperature and accessibility to _____, influences the process biology and level of treatment achieved.

- A. MLSS concentration
- B. WAS
- C. BOD, nutrients, and oxygen
- D. None of the above

Sludge Settling

107. Waste activated sludge determines how long the _____ stays in the system and, therefore, helps to determine which type of microorganisms will be present.

- A. MLSS
- B. WAS
- C. BOD, nutrients, and oxygen
- D. None of the above

108. The presence or absence of _____ will influence how fast the sludge settles in the clarifier.

- A. MLSS concentration
- B. WAS
- C. Filaments
- D. None of the above

109. Waste activated sludge also determines the _____.

- A. MLSS concentration
- B. WAS
- C. BOD, nutrients, and oxygen
- D. None of the above

Organic Load

110. According to the text, as the cells are retained longer in the system, the flocculating characteristics of the cells improve since they start to produce extra cellular slime that favors?

- A. Secondary settling
- C. Flocculating
- B. High degradation rate
- D. None of the Above

111. The organic load (generally coming from primary treatment operations such as settling, screening or flotation) enters the reactor where the active microbial population is present. The reactor must be continuously aerated.

- A. True
- B. False

112. The mixture then passes to a settling tank where the cells are settled. The treated wastewater is disinfected while the secondary settling and is recycled in part to the aeration basin.

- A. True
- B. False

Common Types

113. The most common types of activated sludge are the conventional and the continuous flow stirred tank, in which the contents are completely mixed. In the conventional process, the wastewater is circulated along the aeration tank, with the flow being arranged by baffles in plug flow mode. The oxygen demand for this arrangement is maximum at the inlet as is the organic load concentration.

- A. True
- B. False

Sludge Problems and Solutions Section

Constant MLSS (Mixed Liquor Suspended Solids)

114. Provided the influent loadings are constant, the operator maintains a relatively constant solids inventory (MLSS level) in the aeration basins for a desired level of treatment. The range of MLSS is typically between 1000-4000 mg/L.

- A. True
- B. False

Wasting Rates

115. The concentration of WAS has a direct bearing on how much to waste and the volume wasted. On a volume basis, a thicker waste activated sludge (low WAS concentration) will require more amount of wasting than a thinner waste activated sludge (high WAS concentration).

- A. True
- B. False

Extended Aeration Activated Sludge Plants

116. For extended aeration activated sludge plants the range is between about 15 and 30 days. Generally, during the winter months, higher sludge ages are required to maintain a sufficient biological mass. In the summer time, biological activity increases and lower sludge ages normally produce a higher quality effluent.

- A. True
- B. False

Excess Solids

117. Solids are generated by microorganism growth and reproduction. The influent BOD supplies the food for the growth and reproduction. As microorganisms' populations multiply, excess solids (microorganisms) must be removed (wasted).

- A. True
- B. False

Final Clarifier Solids Loading Rate (SLR)

118. The rate at which the activated sludge is returned from the final clarifiers to the aeration basins, along with the influent flow, effects the flow of solids into the clarifiers.

- A. True
- B. False

Clarifier Sludge Blanket

119. Solids settle and concentrate in the first clarifier forming a sludge blanket. The sludge blanket can increase depending on the WAS flow rate. The proper WAS flow rate allows for a desired sludge blanket.

A. True B. False

Filaments

120. Filamentous organisms are a group of thread-like organisms that, when in excess, can impair the settling of activated sludge and create a bulking condition in the final clarifier.

A. True B. False

Oxidation Ditch

121. Oxidation ditches are typically limited mix systems, and cannot be modified to approach plug flow conditions.

A. True B. False

Pin Floc

122. Very fine floc particles with poor settling characteristics, usually indicative of a young sludge (high MLSS levels).

A. True B. False

Sludge Age

123. Activated sludge (RAS) is recycled back through the aeration basins by returning settled sludge in the final clarifiers and thus remains in the activated sludge system for a number of days. For effective treatment, a specific sludge age is desired for the type of activated sludge system.

A. True B. False

124. For conventional activated sludge, a sludge age of 1-3 days is typical. For extended aeration activated sludge, older sludge ages of 3-10 days are common. F/M ratio and sludge age is inversely related (1 divided by the sludge age approximates the F/M ratio).

A. True B. False

Clarifier Sludge Blanket

125. Solids settle and concentrate in the final clarifiers forming a sludge blanket. The sludge blanket can increase or decrease depending on the RAS flow rate. The proper RAS flow rate allows for a desired sludge blanket.

A. True B. False

Young Sludge

126. Young sludge is often associated with a low F/M. To correct for young sludge, it is necessary to increase wasting rates. This will decrease the amount of solids under aeration, reduce the F/M ratio, and increase the sludge age.

A. True B. False

Excessive Old Sludge

127. The required pressure is an increase in the total system sludge mass. Decreased wasting is required to accomplish that objective. This problem is very rare.

A. True B. False

Return Rates Too Low

128. Thin mixed liquor suspended solids and a sludge blanket build-up of solids. Rising clumps of sludge or gas bubbles may occur in the final clarifier.

A. True B. False

Return Rates Too High

129. A sludge blanket in the final clarifier and a thick return activated sludge.

- A. True B. False

Denitrification in Final Clarifier

130. In the absence of oxygen, a sludge blanket that is too thick and remains in the clarifier too long can denitrify. Nitrates in the sludge will be converted to nitrogen gas. The release of nitrogen gas will cause small gas bubbles that will be observed at the clarifier surface. Clumps of sludge may also rise to the surface.

- A. True B. False

Bacteria and Temperature Effect

131. Washout SRT is affected by temperature. For every 10°C drop in water temperature, the growth rate of bacteria decreases by 50% and the _____ doubles. Growth rates for floc forming and filament forming bacteria are similarly affected.

- A. MLSS C. Washout SRT
B. CBOD D. WAS

Denitrification

132. When _____ flow rates are too low, thick sludge blankets in the final clarifier can result. The operator will see gas bubbles (from ammonia gas) and rising/floating sludge clumps on the clarifier surface.

- A. MLSS C. RAS
B. CBOD D. WAS

Food –To- Microorganism Ratio (F/M Ratio)

133. For microbiological health and effective treatment, the microorganisms (mixed liquor suspended solids) under aeration should be maintained at a certain level for the amount of food (influent BOD) coming into the plant. This is known as the _____.

- A. MLSS C. Food to microorganism ratio
B. CBOD D. WAS

Old Sludge

134. Old sludge filaments include *M. parvicella*, Type 0041, Type 0675, Type 1851 and Type 0803. *M. parvicella* is known for causing foaming and bulking occurrences, especially during winter operating conditions, in WWTPs that must remove ammonia year-round.

- A. True B. False

Stable Nitrification

135. At a water temperature of 20°C, the washout SRT for AOBs is approximately 1.6 weeks and the washout for POAs is approximately 2.0 days. To maintain a stable population and to avoid accidental loss of these bacteria resulting from accidental overwasting, the target SRT would need to be two to three times as long or between 1 and 3 days.

- A. True B. False

Slimy Foam

136. A grayish slimy foam that is very thick is commonly caused by nutrient deficiencies. It is often noted with a slime bulking condition.

- A. True B. False

Foam Trapping

137. A long-term solution includes some facilities using a vacuum truck to remove the foam from the surface. A short-term solution includes eliminating grease from the influent

- A. True B. False

Topic 5 – Nutrient Section

TKN

138. Recalcitrant means a certain compound is difficult to break down. This material can often be broken down given enough time, but not within the time it spends in secondary treatment.

- A. True B. False

139. Inert means the material is safe for all microorganisms.

- A. True B. False

140. The TKN content of influent municipal wastewater is typically between 5,000 and 6,000 mg/L.

- A. True B. False

141. Organic nitrogen compounds in wastewater undergo microbial conversion to NH_3 and ammonium ion NH_4^+ .

- A. True B. False

Ammonia

142. Ammonia is a nutrient that contains _____. Its chemical formula is NH_3 in the un-ionized state and NH_4^+ in the ionized form.

- A. Nitrogen and hydrogen C. Phosphate
B. Total ammonia D. Both total and unionized ammonia

143. Ammonia results can be expressed as: total ammonia (mg/l), un-ionized ammonia (mg/l), total ammonia (as N, mg/l), un-ionized ammonia (_____).

- A. $\mu\text{g/l}$ C. As N, mg/l
B. mg/l/day D. mg/l

Nitrification

144. Ammonia-nitrogen ($\text{NH}_3\text{-N}$) is first converted to nitrite (NO_2^-) by ammonia oxidizing bacteria (AOB). The nitrite produced is then converted to nitrate (NO_3^-) by nitrite oxidizing bacteria (NOB). Both reactions usually occur in the same process unit at a wastewater treatment plant (e.g., activated sludge mixed liquor or fixed film biofilm).

- A. True B. False

145. Nitrification is an anaerobic process in which heterotrophic bacteria oxidize carbon for energy production.

- A. True B. False

146. Nitrification is normally a one-step aerobic biological process for the oxidation of ammonia to nitrate.

- A. True B. False

Nitrifying Bacteria

147. Ammonia can be converted into nitrite and nitrate by nitrifying bacteria. Effluent ammonia-nitrogen ($\text{NH}_3\text{-N}$) concentrations less than 1 mg/L $\text{NH}_3\text{-N}$ are achievable.

- A. True B. False

Autotrophic Bacteria

148. AOB and NOB are classified as autotrophic bacteria because they derive energy from the oxidation of reduced inorganic compounds (in this case, nitrogenous compounds) and use inorganic carbon (CO₂) as a food source.

A. True B. False

Significant Amount of Oxygen

149. Nitrifying bacteria require a significant amount of oxygen to complete the reactions, produce a small amount of biomass, and cause destruction of alkalinity through the consumption of carbon dioxide and production of hydrogen ions.

A. True B. False

Nitrogen Gas

150. Nitrate can be converted to nitrogen gas by a variety of autotrophic bacteria. The nitrogen gas is returned to the digester.

A. True B. False

151. Nitrate removal is limited by the amount of COD available.

A. True B. False

Total Inorganic Nitrogen (TIN)

152. Total inorganic nitrogen (TIN) as low as 5 mg/L N can be met through biological nitrification and denitrification.

A. True B. False

Total Nitrogen

153. Total nitrogen in domestic wastewater typically ranges from 1.5 to 2.0 mg/L for low to high strength wastewater.

A. True B. False

154. Factors affecting concentration include the extent of infiltration and the presence of industries. Influent concentration varies during the day and can vary significantly during rainfall events, as a result of inflow and infiltration to the collection system.

A. True B. False

Conversion of Nitrate to Nitrogen Gas

155. In this oxygen free environment, bacteria use the oxygen attached to the nitrogen that is in the nitrate form, then the nitrogen gas is released.

A. True B. False

156. Because nitrogen contains almost 50 percent of the earth's atmosphere, the release of nitrogen into the atmosphere causes a small amount of global warming.

A. True B. False

157. The conversion of nitrate to nitrogen gas is accomplished by bacteria in a process known as denitrification. Effluent with nitrogen in the form of nitrate is retained in a tank that lacks oxygen, where carbon-containing chemicals, such as methanol, are added or a small stream of raw wastewater is mixed in with the nitrified effluent.

A. True B. False

Phosphorus Section

158. Total phosphorus (TP) in domestic wastewater typically ranges between _____ mg/L but can be higher depending on industrial sources, water conservation, or whether a detergent ban is in place.

- A. 4 and 8
- B. 2 and 4
- C. 100 to 500
- D. 1,000 – 2,000

159. The _____ fraction is soluble and can be in one of several forms (e.g., phosphoric acid, phosphate ion) depending on the solution pH.

- A. Orthophosphate
- B. Phosphorus
- C. Phosphoric acid, phosphate ion
- D. Total phosphorus (TP)

160. Polyphosphates are high-energy, condensed _____ such as pyrophosphate and trimetaphosphate. They are also soluble but will not be precipitated out of wastewater by metal salts or lime. They can be converted to phosphate through hydrolysis, which is very slow, or by biological activity.

- A. Polyphosphates
- B. Phosphorus
- C. Phosphates
- D. Soluble organically bound non-biodegradable phosphorus

161. _____ can either be in the form of soluble colloids or particulate. It can also be divided into biodegradable and non-biodegradable fractions.

- A. Organically bound phosphorus
- B. Phosphorus
- C. Soluble biodegradable phosphorus
- D. Particulate organically bound phosphorus

162. _____ is generally precipitated out and removed with the sludge.

- A. Organically bound phosphorus
- B. Phosphorus
- C. Soluble biodegradable phosphorus
- D. Particulate organically bound phosphorus

163. _____ can be hydrolyzed into orthophosphate during the treatment process.

- A. Polyphosphate
- B. Phosphorus
- C. Particulate organically bound phosphorus
- D. Soluble organically bound non-biodegradable phosphorus

Biological Phosphorus Control

164. Phosphorus removal can be achieved through chemical addition and a coagulation-sedimentation process discussed in the following section. Some biological treatment processes called biological nutrient removal (BNR) can also achieve nutrient reduction, removing _____.

- A. Polyphosphate
- B. Phosphorus
- C. Both nitrogen and phosphorus
- D. Soluble organically bound non-biodegradable phosphorus

Phosphate Accumulating Organisms (PAOs)

165. PAOs accomplish removal of phosphate by accumulating it within their cells as _____.

- A. Polyphosphate
- B. Phosphorus
- C. Both nitrogen and phosphorus
- D. Soluble organically bound non-biodegradable phosphorus

Production of Polyphosphate

166. PAOs are by no means the only bacteria that can accumulate _____ within their cells and in fact, the production of polyphosphate is a widespread ability among bacteria.

- A. Polyphosphate
- B. Phosphorus
- C. Phosphoric acid, phosphate ion
- D. Total phosphorus (TP)

Luxury Uptake

167. In an anaerobic secondary treatment process, some of the CBOD is broken down through fermentation by anaerobic bacteria into soluble CBOD and simpler organic molecules called _____.

- A. COD
- B. VFAs
- C. Carbon and energy
- D. ATP

168. Volatile fatty acids are a preferred source of _____ by heterotrophic bacteria, including the PAOs, because these compounds are easily absorbed into the bacteria.

- A. COD
- B. VFAs
- C. Carbon and energy
- D. ATP

Logistical Problem

169. The PAOs have a logistical problem: When PAOs are under anaerobic conditions, they are exposed to _____, but without oxygen, nitrite or nitrate present, they cannot access them.

- A. COD
- B. VFAs
- C. Carbon and energy
- D. ATP

Adenosine Triphosphate (ATP) Energy

170. The PAOs take ATP to the next level and form an energy-rich compound called _____, which strings together large numbers of phosphate molecules.

- A. Polyphosphate
- B. VFAs
- C. Carbon and energy
- D. ATP

Chemical Precipitation of Phosphorus

171. Phosphorus can also be precipitated through chemical addition. Alum, ferric chloride, or lime can be added to wastewater where these chemicals combine with phosphorus to form a solid. The precipitate is removed by settling or filtration.

- A. True
- B. False

172. Chemical phosphorus removal can meet effluent levels as low as 0.03 mg/L TP. Chemical and biological phosphorus removal methods are often used together in various combination processes.

- A. True
- B. False

Tertiary Filtration

173. WWTPs typically use biological phosphorus removal methods to reduce P concentrations above 50 mg/L as P followed by chemical precipitation at or after the secondary clarifier.

- A. True
- B. False

Biological Phosphorus Removal and Combination Processes

Principles

174. Biological phosphorus removal is achieved by contacting phosphorus accumulating organisms (PAOs) in the RAS with feed, containing volatile fatty acids (VFA), in a zone free of nitrates and DO (anaerobic zone).

- A. True
- B. False

Fuhs & Chen Theory

175. PAOs have the ability to store a large mass of _____ in their cells in the form of polyphosphates.

- A. Carbon
- B. Phosphorus
- C. Poly- β -hydroxybutyrate (PHB)
- D. Magnesium and potassium ions

University of Cape Town (UCT) and Modified UCT (MUCT)

176. The UCT process was designed to reduce _____ to the anaerobic zone when high removal of nitrates in the effluent is not required. It consists of three stages: an anaerobic stage, an anoxic stage, and an aerobic stage.

- A. Nitrates
- B. A nitrate rich stream
- C. An anoxic zone
- D. An aerobic stage

Johannesburg (JHB), Modified Johannesburg and Westbank

177. The JHB process is similar to the 3 Stage Pho-redox process, but has a pre-anoxic tank ahead of the anaerobic zone to protect the zone from nitrates when low effluent nitrates are not required. The low COD of the wastewater limited the de-nitrification capacity in the original plant (Northern Works), resulting in nitrates in the _____.

- A. RAS
- B. Pre-anoxic zone
- C. An anoxic zone
- D. An aerobic stage

Nitrification and Nutrient Removal Sub-Section

178. Which of the following bugs require a neutral pH and substantial alkalinity?

- A. Nitrifying bacteria
- B. Methane forming bacteria
- C. Anaerobic, heterotrophic bacteria
- D. None of the Above

179. Nitrifying bacteria exists in low numbers in lagoons, they prefer attached growth systems and/or?

- A. Nitrifying bacteria
- B. Low MLSS sludge systems
- C. High MLSS sludge systems
- D. None of the Above

180. Complete nitrification would be expected at pond pH values between pH _____.

- A. 7.5 and 9.5
- B. 7.0 and 8.5
- C. 6.0 and 7.5
- D. None of the Above

181. Nitrification ceases at pH values above pH _____ and declines markedly at pH values below _____.

- A. 9 and 6
- B. 8 and 5
- C. 9 and 7
- D. None of the Above

182. Nitrification, however, is not a major pathway for nitrogen removal in lagoons. Nitrifying bacteria exists in low numbers in lagoons. They prefer _____ and/or high MLSS sludge systems.

- A. Nitrifying bacteria
- B. Low MLSS sludge systems
- C. Attached growth systems
- D. None of the Above

183. Which of the following bugs or related terms commonly occur in lagoons are involved in methane formation and in sulfate reduction?

- A. Nitrifying bacteria
- B. Methane forming bacteria
- C. Anaerobic, heterotrophic bacteria
- D. None of the Above

184. Anaerobic methane formation involves _____ bacteria.

- A. Three different groups of anaerobic
- B. Methane fermentation
- C. Organic overloading conditions
- D. None of the Above

185. Which of the following genera of anaerobic bacteria hydrolyze proteins, fats, and polysaccharides present in wastewater to amino acids?

- A. Nitrifying bacteria
- B. Methane forming bacteria
- C. General anaerobic degraders
- D. None of the Above

186. *Nitrosomonas europaea*, which oxidizes ammonia to nitrite, and *Nitrobacter winogradskyi*, which oxidizes nitrite to nitrate.

- A. True
- B. False

187. Nitrification ceases at pH values above pH 9 and declines markedly at pH values below 7.

- A. True
- B. False

188. Nitrification is a major pathway for nitrogen removal in lagoons.

- A. True
- B. False

Photosynthetic Organisms

189. A problem exists at times where the acid formers overproduce organic acids, lowering the pH below where the methane bacteria can function (a pH < 6.5). This can stop methane formation and lead to a buildup of sludge in a lagoon with a low pH. In an anaerobic fermenter, this is known as a "stuck digester".

- A. True
- B. False

190. Which of the following bugs or related terms is a diverse group of bacteria that converts products from above under anaerobic conditions to simple alcohols and organic acids?

- A. Acid-forming bacteria
- B. Methane bacteria
- C. Aerobic bacteria
- D. None of the Above

191. Which of the following bugs or related terms these bacteria convert formic acid, methanol, methylamine, and acetic acid under anaerobic conditions to methane?

- A. Nitrifying bacteria
- B. Methane forming bacteria
- C. General anaerobic degraders
- D. None of the Above

192. Which of the following bugs or related terms are environmentally sensitive and have a narrow pH range of 6.5-7.5 and require temperatures > 14° C.

- A. Acid-forming bacteria
- B. Methane bacteria
- C. Aerobic bacteria
- D. None of the Above

193. Which of the following bugs or related terms that the products of these bugs become the substrate for the methane producers?

- A. Acid formers (principally acetic acid)
- B. Methane bacteria
- C. Aerobic bacteria
- D. None of the Above

194. Which of the following bugs or related terms ceases at cold temperature?

- A. Acid-forming bacteria
- B. Methane fermentation
- C. Aerobic bacteria
- D. None of the Above

195. Which of the following bugs or related terms can use sulfate as an electron acceptor, reducing sulfate to hydrogen sulfide?

- A. Nitrifying bacteria
- B. Methane forming bacteria
- C. Sulfate reducing bacteria
- D. None of the Above

196. Which of the following bugs or related terms is a major cause of odors in ponds?

- A. Sulfate reduction
- B. Methane fermentation
- C. Acid-forming bacteria
- D. None of the Above

197. Which of the following bugs or related terms and represented by about 28 genera, oxidize reduced sulfur compounds using light energy to produce sulfur and sulfate?

- A. Nitrifying bacteria
- B. Methane forming bacteria
- C. Red and green sulfur bacteria
- D. None of the Above

198. Which of the following bugs or related terms that can grow in profusion and give a lagoon a pink or red color?

- A. Chromatium, Thiocystis, and Thiopedia
- B. Methane bacteria
- C. Acid-forming bacteria
- D. None of the Above

199. According to the text, conversion of odorous sulfides to sulfur and sulfate by these bugs is a significant odor control mechanism in facultative and anaerobic lagoons.

- A. Methane bacteria
- B. Sulfur bacteria
- C. Acid-forming bacteria
- D. None of the Above

Nutrient Constituents in Wastewater and Measurement Methods

Nitrogen

200. The per capita contribution of nitrogen in domestic wastewater is about 1/10th of that for BOD.

- A. True
- B. False

201. Which of the following in domestic wastewater typically ranges from 20 to 70 mg/L for low to high strength wastewater?

- A. Organic carbon
- B. Total nitrogen
- C. BOD
- D. None of the Above

202. The major contributors of nitrogen to wastewater are _____ such as food preparation, showering, and waste excretion.

- A. Human activities
- B. Oxygen-demanding pollutants
- C. Bacteria and other microbes
- D. None of the Above

203. Influent concentration varies during the day and can vary significantly during rainfall events, as a result of?

- A. Oxygen-demanding pollutants
- B. Dissolved oxygen decrease
- C. Inflow and infiltration to the collection system
- D. None of the Above

The TKN method has three major steps:

204. Digestion to convert organic nitrogen to?

- A. Ammonium sulfate
- B. Organic nitrogen
- C. Dissolved, biodegradable compounds
- D. None of the Above

205. Conversion of which term into condensed ammonia gas through addition of a strong base and boiling?

- A. Ammonia gas
- B. Ammonium sulfate
- C. Ammonia-nitrogen concentration
- D. None of the Above

206. Measuring the concentration includes ammonia, with this term being subtracted from the TKN to determine organic nitrogen.

- A. Ammonia gas
- B. Ammonium sulfate
- C. Ammonia-nitrogen concentration
- D. None of the Above

207. Nitrogen components in wastewater are typically reported on an “_____” basis?

- A. As Nitrite
- B. As Nitrate
- C. As nitrogen
- D. None of the Above

208. Wastewater treatment plants are designed for nitrification and denitrification and these can remove 80 to 95 percent of _____, but the removal of organic nitrogen is typically much less efficient.

- A. TKN
- B. Inorganic nitrogen
- C. Aliphatic N compounds
- D. None of the Above

209. According to the text, domestic wastewater organic nitrogen may be present in particulate, colloidal or dissolved forms and consist of proteins, amino acids, _____, refractory natural compounds in drinking water.

- A. VFAs
- B. Nitrites
- C. Aliphatic N compounds
- D. None of the Above

210. Which of the following may be released in secondary treatment by microorganisms either through metabolism or upon death and lysis?

- A. TKN
- B. Organic nitrogen
- C. Aliphatic N compounds
- D. None of the Above

211. Which of the following happens by microorganisms releases some organic nitrogen as dissolved, biodegradable compounds?

- A. Ammonia gas
- B. THMs
- C. Hydrolysis of particulate and colloidal material
- D. None of the Above

212. Other forms of _____ may be more persistent in wastewater treatment processes.

- A. TKN
- B. Organic nitrogen
- C. Dissolved, biodegradable compounds
- D. None of the Above

Filamentous Bacteria

213. According to the text, filaments are _____ that grow in long thread-like strands or colonies.

- A. Bacteria and fungi
- B. Facultative Bacteria
- C. Anaerobic to aerobic state Bacteria
- D. None of the Above

214. According to the text, filamentous bacteria function similar to _____ since they degrade BOD quite well.

- A. Floc forming bacteria
- B. Activated sludge
- C. Biofilm bacteria
- D. None of the Above

Site Specific Bacteria

215. Aeration and biofilm building are the key operational parameters that contribute to the efficient degradation of organic matter (BOD/COD removal).

- A. True
- B. False

Facultative Bacteria

216. Most of the bacteria absorbing the organic material in a wastewater treatment system are facultative in nature, meaning they are adaptable to survive and multiply in either anaerobic or aerobic conditions.

- A. True B. False

217. According to the text, usually, facultative bacteria will be _____ unless there is some type of mechanical or biochemical process used to add oxygen to the wastewater.

- A. Anaerobic C. Aerobic
B. Application-specific bacteria D. None of the Above

Anaerobic Bacteria

218. A typical use for _____ would be in a septic tank.

- A. Aerobic bacteria C. Facultative bacteria
B. Anaerobic bacteria D. None of the Above

219. Which of the following or bugs release hydrogen sulfide as well as methane gas, both of which can create hazardous conditions?

- A. Aerobic bacteria C. Facultative bacteria
B. Anaerobic bacteria D. None of the Above

220. Which of the following live and reproduce in the absence of free oxygen?

- A. Aerobic bacteria C. Facultative bacteria
B. Anaerobic bacteria D. None of the Above

221. In order to remove a given amount of organic material in an anaerobic treatment system, the organic material must be exposed to a _____ and/or detained for a much longer period of time.

- A. Anaerobic action C. Significantly higher quantity of bacteria
B. Absence of free oxygen D. None of the Above

Aerobic Bacteria

222. Aerobic bacteria live and multiply in the presence of free oxygen.

- A. True B. False

223. Facultative bacteria always achieve an aerobic state when oxygen is present.

- A. True B. False

224. The metabolism of aerobes is much higher than?

- A. Application-specific bacteria C. Aerobic bacteria
B. Anaerobes D. None of the Above

225. The by-products of _____ are carbon dioxide and water.

- A. Anaerobic action C. Aerobic bacteria
B. Application-specific bacteria D. None of the Above

Bacteria Section

226. Many bacteria exist as _____ and the study of biofilms is very important.

- A. Filamentous Bacteria C. Application-specific bacteria
B. A biofilm D. None of the Above

227. Bacteria come in a variety of shapes. The. Bacteria formed like simple shapes, round spheres or balls are called Cocci (singular coccus). The next simplest shape is cylindrical. Cylindrical bacteria are called rods (singular rod).

- A. True B. False

Peritrichous Bacteria

228. Pleomorphic bacteria can assume a variety of shapes.

- A. True B. False

229. Bacteria may be classified according to whether they require oxygen (aerobic or anaerobic) and how they react to a test with Gram's stain.

- A. True B. False

230. Bacteria in which alcohol washes away Gram's stain is called gram-negative, while bacteria in which alcohol causes the bacteria's walls to absorb the stain are called Gram-positive.

- A. True B. False

Shigella dysenteriae

231. Salmonella is spread by contaminated water and food, causes the most severe dysentery because of its potent and deadly Shiga toxin, but other species may also be dysentery agents.

- A. True B. False

232. Shigellae are Gram-negative, non-spore-forming, facultatively anaerobic, Pleomorphic bacteria.

- A. True B. False

Salmonella

233. Salmonellae usually do not ferment lactose; most of them produce hydrogen sulfide that, in media containing _____, reacts to form a black spot in the center of the creamy colonies.

- A. Ferric ammonium citrate C. Alum sulfate
B. Hydrogen sulfide D. None of the Above

Fecal Coliform Bacteria

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

- A. Fecal matter C. Fecal coliform bacteria
B. Fecal concentration D. None of the Above

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

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

Protozoans and Metazoans

236. Which of the following or bugs and the relative abundance of certain species can be a predictor of operational changes within a treatment plant?

- A. Nematodes and rotifers C. Protozoans and metazoans
B. Macroinvertebrates D. None of the Above

237. In a wastewater treatment system, the next higher life form above bacteria is?

- A. Nematodes
- B. Rotifers
- C. Protozoan(s)
- D. None of the Above

238. Which of the following or bugs are also indicators of biomass health and effluent quality?

- A. Aerobic flocs
- B. Protozoans
- C. Biomass health and effluent quality
- D. None of the Above

239. Which of the following or bugs are very similar to protozoans except that they are usually multi-celled animals?

- A. Nematodes and rotifers
- B. Metazoan(s)
- C. Worms
- D. None of the Above

Dispersed Growth

240. Dispersed growth is material suspended within the activated sludge process that has not been adsorbed into the floc particles. This material consists of very small quantities of colloidal (too small to settle out) bacteria as well as organic and inorganic particulate material.

- A. True
- B. False

241. According to the text, while a small amount of _____ between the floc particles is normal, excessive amounts can be carried through a secondary clarifier.

- A. Denitrification
- B. Dispersed growth
- C. Bulking sludge
- D. None of the Above

Paramecium sp.

242. Paramecium may also be seen paired up with a _____ which makes a good diagnostic key.

- A. Shelled amoeba(s)
- B. Paramecium
- C. Vorticella
- D. None of the Above

243. Which of the following bugs is a medium to large size (100-300 μm) swimming ciliate, commonly observed in activated sludge, sometimes in abundant numbers?

- A. Shelled amoeba(s)
- B. Paramecium
- C. Euglypha
- D. None of the Above

244. Which of the following bugs is uniformly ciliated over the entire body surface with longer cilia tufts at the rear of the cell.

- A. Paramecium
- B. Euglypha
- C. Shelled amoeba(s)
- D. None of the Above

Activated Sludge Bugs

245. The second and third groups of bugs are microorganisms known as the free-swimming and _____. These larger bugs eat the bacteria and are heavy enough to settle by gravity.

- A. Stalked ciliates
- B. Suctoria
- C. Activated sludge bugs
- D. None of the Above

246. Which bug feeds on the larger bugs and assist with settling is in the fourth group, known as?

- A. Water bear
- B. Suctoria
- C. Rotifer
- D. None of the Above

247. The Bacteria have several interesting properties--their "fat reserve" is stored on the outside of their body and this strange feature?

- A. Fur
- B. Feet
- C. No Mouth
- D. None of the Above

248. Once the bacteria have "contacted" their food, they start the digestion process. A chemical Enzyme is sent out through the cell wall to break up the_____.

- A. Mixed liquor
- B. Organic compounds
- C. Total Dissolved Solids
- D. None of the Above

249. The cell is highly engineered and because of this hydrolytic enzyme, it breaks the organic molecules into small units that are able to pass through the cell wall of the _____.

- A. Mixed bugs
- B. Compound
- C. Bacteria
- D. None of the Above

250. In wastewater treatment, the process of using bacteria-eating-bugs in the presence of oxygen to reduce the organics in water is called?

- A. Mixed liquor
- B. Oxidation
- C. Activated sludge
- D. None of the Above

251. In the Activated Sludge process, the _____are also called waste activated sludge.

- A. Organisms
- B. Settled bugs
- C. Mixed liquor
- D. None of the Above

252. The first group is the bacteria which eat the dissolved organic compounds is generally four (4) groups of bugs that do most of the "eating" in the _____process.

- A. Mixed liquor
- B. Settled bugs
- C. Activated sludge
- D. None of the Above

253. An asset in settling the bug is its fat storage property and as the bugs "bump" into each other, the fat on each of them sticks together and causes flocculation of the_____.

- A. Mixed liquor
- B. Floc
- C. Non-organic solids and biomass
- D. None of the Above

254. What does facultative mean as far as bugs? What environments are they adaptable to survive and multiply in?

- A. Aerobic only
- B. Anaerobic only
- C. Either anaerobic or aerobic conditions
- D. None of the Above

255. The next step as in the text, this substance, which is the activated sludge, is used again by returning it to the influent of the aeration tank for mixing with the primary effluent and ample amounts of air?

- A. Carry over
- B. RAS
- C. Solids biomass
- D. None of the Above

256. We need to be able to properly identify the bugs and which commonly found bug is a medium size to large swimming Ciliate, commonly observed in activated sludge, sometimes in abundant numbers.

- A. Vorticella
- B. Euglypha
- C. Paramecium
- D. None of the Above

Vorticella sp.

257. Which of the following bugs feeds by producing a vortex with its feeding cilia?

- A. Shelled amoeba(s)
- B. Vorticella
- C. Euglypha
- D. None of the Above

258. According to the text, if treatment conditions are bad, for example, low DO or toxicity, _____ will leave their stalks.

- A. Shelled amoeba(s)
- B. Euglypha
- C. Vorticella
- D. None of the Above

Euglypha sp.

259. Which of the following bugs spines may be single or in groups of two or three?

- A. Shelled amoeba(s)
- B. Euglypha
- C. Vorticella
- D. None of the Above

260. The shell of this bug is often transparent, allowing the hyaline (watery) body to be seen inside the shell.

- A. Euglypha
- B. Shelled amoeba(s)
- C. Euchlanis
- D. None of the Above

261. Which of the following bugs are common in soil, treatment plants, and stream bottoms where decaying organic matter is present?

- A. Shelled amoeba(s)
- B. Euglypha
- C. Stalked ciliate
- D. None of the Above

Euchlanis sp.

262. Euchlanis is a typical?

- A. Euglypha
- B. Shelled amoeba(s)
- C. Rotifer(s)
- D. None of the Above

263. Euchlanis is a swimmer, using its foot and cilia for locomotion. In common with other rotifers, it has a head rimmed with cilia, a transparent body, and a foot with two strong swimming toes.

- A. True
- B. False

Activated Sludge Aerobic Flocs

264. Aerobic flocs in a healthy state are referred to as activated sludge. While aerobic floc has a metabolic rate approximately 10 times higher than anaerobic sludge, it can be increased even further by exposing the bacteria to an abundance of oxygen.

- A. True
- B. False

Problems may appear during the operation of activated sludge systems, including:

265. Which of the following that which settles too slowly and is not compactable, and caused by the predominance of filamentous organisms?

- A. Settling sludge
- B. Organic material
- C. Bulking sludge
- D. None of the Above

266. Which of the following terms' content in clarified effluent, which may be due to too high or too low solids retention time and to growth of filamentous microorganisms?

- A. Organic material
- B. High solids
- C. Biomass health and effluent quality
- D. None of the Above

267. Which of the following occurs when sludge that normally settles rises back to the surface after having settled?

- A. Denitrification
- B. Bulking sludge
- C. Rising sludge
- D. None of the Above

Filamentous Organisms

268. Which of the following reach too high a concentration, they can extend dramatically from the floc particles?

- A. Filamentous organisms
- B. Floc particles
- C. Organic material
- D. None of the Above

Filamentous Bacteria Identification

269. The foam from *Nocardia amarae* is usually a _____ unless algae are entrapped in it, in which case it appears green and brown.

- A. Viscous brown color
- B. Staining gram-positive
- C. Gram-positive, chemoautotrophic, filamentous
- D. None of the Above

270. Filamentous Identification should be used as a tool to monitor the health of the biomass when a floating scum mat is suspected.

- A. True
- B. False

271. *Nostocoida* can also be identified by their starburst effect formations using phase contrast microscopy at 400 to 1000x magnification. After chlorination, a few dead cells sticking out identify stress to this species.

- A. True
- B. False

Microthrix parvicella

272. *Microthrix parvicella* is another common cause of?

- A. Disruptive foaming
- B. Mixotrophic
- C. Viscous brown color
- D. None of the Above

Sphaeroliticus natans

273. *Sphaeroliticus natans* is another filamentous species, and yet it is reputed to increase settleability by branching between flocs, increasing surface area.

- A. True
- B. False

274. Which of the following requires high levels of oxygen are necessary?

- A. Stain gram-negative
- B. A strict aerobe
- C. Slower growing filaments
- D. None of the Above

Filamentous Bacteria

275. Different filamentous bacteria such as *Microthrix*, *Sphaerotilus*, *Nostocoida*, *Thiothrix* or "Type 021N" and others cause?

- A. Bulking for very different reasons
- B. Dissolved oxygen decrease
- C. Sludge bulking
- D. None of the Above

276. There is a potential for instability with _____ is an acute problem when strict demands on treatment performance are in place.

- A. Organic carbon
- B. Activated sludge
- C. High BOD
- D. None of the Above

Biological Criteria Sub-Section

Water Quality Criteria

277. The Clean Water Act directs the EPA to develop criteria for water quality that accurately reflect the latest scientific knowledge about the effects of pollutants on aquatic life and human health.

- A. True B. False

278. The Clean Water Act and the EPA includes specific information on the concentration and dispersal of pollutants through biological, physical, and chemical processes as well as the effects of pollutants on biological communities as a whole.

- A. True B. False

Human Health Criteria

279. EPA scientists research information to determine the levels at which specific chemicals are not likely to adversely affect water quality standard(s).

- A. True B. False

Aquatic Life Criteria

280. Allowable concentrations provide protection for plants and animals that are found in surface waters.

- A. True B. False

Biological Criteria

281. A water body in its natural condition is free from _____, habitat loss, and other negative stressors.

- A. Allowable concentrations C. Acute (short term) and chronic (long term)
B. Harmful effects of pollution D. Human health and aquatic life criteria

282. The EPA is developing methodologies that states can use to assess the biological integrity of their waters and, in so doing, set protective _____?

- A. Water quality standards C. Acute (short term) and chronic (long term)
B. Harmful effects of pollution D. Human health and aquatic life criteria

283. These methodologies will describe scientific methods for determining a particular aquatic community's health and for maintaining optimal conditions in _____?

- A. Allowable concentrations C. Various bodies of water
B. Water quality D. Human health and aquatic life criteria

Genera

284. Which of the following means the microorganisms that are attached to a surface over which they grow are called "attached growth processes"?

- A. Carbonaceous BOD C. Suspended growth processes
B. Attached growth processes D. Biomat

Laboratory Analysis/ Process Control Section

pH Testing Section

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

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

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

- A. True B. False

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

- A. True B. False

288. Pure water has a pH very close to?

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

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

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

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

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

291. pH is defined as the decimal logarithm of the reciprocal of the _____, a_{H^+} , in a solution.

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

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

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

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

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

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

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

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

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

296. The pH scale is logarithmic and therefore pH is?

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

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

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

298. The calculation of the pH of a solution containing acids and/or bases is an example of a chemical speciation calculation, that is, a mathematical procedure for calculating the concentrations of all chemical species that are present in the solution. The complexity of the procedure depends on the?

- A. Nature of the solution
- B. pH
- C. Alkaline earth metal concentrations
- D. None of the Above

299. For strong acids and bases no calculations are necessary except in extreme situations. The pH of a solution containing a weak acid requires?

- A. The concentration value
- B. The solution of a quadratic equation
- C. Excess of alkaline concentrations
- D. None of the Above

300. Alkalinity in excess of which term is significant in determining the suitability of water for irrigation?

- A. 8
- B. pH of 7
- C. Alkaline earth metal concentrations
- D. None of the Above

301. The calculation of the pH of a solution containing acids and/or bases is an example of a _____ calculation, that is, a mathematical procedure for calculating the concentrations of all chemical species that are present in the solution

- A. Chemical speciation
- B. Spectrophotometer
- C. Visual comparison
- D. None of the Above

302. Since pH is a logarithmic scale, a difference of one pH unit is equivalent to _____ difference in hydrogen ion concentration.

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

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

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

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

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

305. The pH of a solution containing a _____ may require the solution of a cubic equation.

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

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

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

307. The pH scale is traceable to a set of standard solutions whose pH is established by US EPA.
A. True B. False

Dissolved Oxygen Testing Section

308. Aerobic means without air and some bacteria thrive under these conditions and utilize the nutrients and chemicals available to exist.
A. True B. False

309. Aerobes decompose inorganics in the water; the result is carbon dioxide and H₂SO₄.
A. True B. False

310. Dissolved oxygen (DO) in water is considered a contaminant.
A. True B. False

311. The saprophytes exist on dead or decaying materials.
A. True B. False

312. The methane fermenting bacteria require a pH range of 6.6 to 7.6 to be able to live and reproduce.
A. True B. False

313. Aerobic bacteria do not require oxygen to live and thrive.
A. True B. False

314. At least two general forms of bacteria act in balance in a wastewater digester: Saprophytic organisms and?
A. Methane Fermenters C. Butyric acid fermenters
B. DO fermenters D. Carbon dioxide fermenters

315. Dissolved oxygen level is important because too much or not enough dissolved oxygen can create _____?
A. Unfavorable conditions C. Frequent dissolved oxygen measurement
B. DO analysis D. None of the Above

316. A lack of Dissolved oxygen in natural waters creates?
A. Anaerobic conditions C. Aerobic Conditions
B. Denitrification D. None of the Above

317. Which of the following live on the volatile acids produced by these saprophytes?
A. Butyric acid fermenters C. VFAs
B. Methane fermenters D. None of the Above

318. Which of the following indicate that dissolved oxygen is present?
A. Sample(s) C. Aerobic conditions
B. DO analysis D. None of the Above

319. _____ in a water sample can be detrimental to metal pipes in high concentrations because oxygen helps accelerate corrosion.
A. Carbon dioxide C. Dissolved Oxygen
B. pH D. None of the Above

320. Oxygen is an important component in water plant operations. Its primary value is to oxidize iron and manganese into forms that will precipitate out of the water. It also removes excess

- _____.
- A. Carbon dioxide
 - B. Water sample
 - C. Molecular oxygen
 - D. None of the Above

321. The amount of _____ in a water sample will affect the taste of drinking water also.

- A. Carbon dioxide
- B. Water
- C. Dissolved oxygen
- D. None of the Above

Methods of Determination

322. There are two methods that we will be using in the lab. The membrane electrode method procedure is based on the rate of diffusion of _____ across a membrane. The other is a titrimetric procedure (Winkler Method) based on the oxidizing property of the (DO).

- A. Carbon dioxide
- B. Water
- C. Molecular oxygen
- D. None of the Above

323. Many factors determine the solubility of oxygen in a water sample. Temperature, atmospheric pressure, salinity, biological activity and pH all have an effect on the (DO) content.

- A. True
- B. False

Iodometric Test

324. The iodometric (titration) test is not a very precise and reliable for (DO) analysis of samples.

- A. True
- B. False

325. Reactions take place with the addition of certain chemicals that liberate iodine equivalent to the?

- A. Original (DO) content
- B. Dissolved Oxygen
- C. Anaerobic conditions
- D. None of the Above

326. Which of the following can liberate iodine from iodides and some reducing agents reduce iodine to iodide?

- A. Ammonia oxidation
- B. Phosphorus removal
- C. Certain oxidizing agents
- D. None of the Above

327. Which of the following effectively removes interference caused by nitrates in the water sample, so a more accurate determination of (DO) can be made?

- A. Winkler Method
- B. Dissolved Oxygen
- C. The alkaline Iodide-Azide reagent
- D. None of the Above

328. Which of the following is highly dependent on the source and characteristics of the sample?

- A. Methods of analysis
- B. DO analysis
- C. Aerobic conditions
- D. None of the Above

329. Which of the following passes through the membrane and measured by the meter?

- A. Carbon dioxide
- B. Dissolved Oxygen
- C. Only molecular oxygen
- D. None of the Above

330. Membrane electrodes provide an excellent method for _____ in polluted, highly colored turbid waters and strong waste effluents.

- A. Sample(s)
- B. DO analysis
- C. Aerobic conditions
- D. None of the Above

331. Proper samples must be taken in _____ bottles where agitation or contact with air is at a minimum.

- A. BOD
- B. DO analysis
- C. MLSS measurement
- D. None of the Above

332. Which of the following—is the one of the most important analyses in determining the quality of natural waters?

- A. Anaerobic conditions
- B. Undissolved Oxygen
- C. The dissolved oxygen test
- D. None of the Above

333. Which of the following measurement is essential for adequate process control?

- A. Dissolved oxygen
- B. DO analysis
- C. Aerobic conditions
- D. None of the Above

334. The magnetic method involves an oxygen permeable plastic membrane that serves as a diffusion barrier against impurities.

- A. True
- B. False

335. The effect of oxidation wastes on streams, the suitability of water for fish and other organisms and the progress of self-purification can all be measured or estimated from the dissolved oxygen content.

- A. True
- B. False

Total Dissolved Solids

336. Pure water is tasteless, colorless, and odorless and is often called the universal solvent.

- A. True
- B. False

337. Which of the following refers to any minerals, salts, metals, cations or anions dissolved in water?

- A. Total Solids
- B. TDS
- C. Total Suspended solids
- D. Dissolved solids

338. Which of the following comprise inorganic salts and some small amounts of organic matter that are dissolved in water?

- A. Settleability
- B. Total dissolved solids (TDS)
- C. Quality of the water
- D. Total Solids

339. The TDS test does not provide us insight into the specific water quality issues, such as: Elevated Hardness, Salty Taste, or?

- A. Total Solids
- B. TDS
- C. Corrosiveness
- D. Alkalinity

Total Solids

340. Which of the following includes both total suspended solids, the portion of total solids retained by a filter and total dissolved solids?

- A. Total Solids
- B. TDS
- C. Corrosiveness
- D. Alkalinity

341. Which of the following can be measured by evaporating a water sample in a weighed dish, and then drying the residue in an oven at 103 to 105° C?

- A. Total Solids
- B. TDS
- C. Total Suspended solids
- D. Alkalinity

342. Which of the following refers to matter suspended or dissolved in water or wastewater, and is related to both specific conductance and turbidity?

- A. Total Solids
- B. TDS
- C. Corrosiveness
- D. Alkalinity

343. Which of the following are the term used for material left in a container after evaporation and drying of a water sample?

- A. Total Solids
- B. TDS
- C. Total Suspended solids
- D. Alkalinity

344. The increase in weight of the dish represents the total solids. Instead of total solids, laboratories often measure total suspended solids and/or total dissolved solids.

- A. True
- B. False

Total Suspended Solids (TSS)

345. When suspended solids settle to the bottom of a water body, they can smother the eggs of fish and aquatic insects, as well as suffocate newly hatched insect larvae.

- A. True
- B. False

346. Total Suspended Solids (TSS) are solids in water that can be trapped by a filter.

- A. True
- B. False

347. Which of the following can also cause an increase in surface water temperature, because the suspended particles absorb heat from sunlight?

- A. Total Solids
- B. High TSS
- C. Total Suspended solids
- D. Alkalinity

348. Which of the following can fill in spaces between rocks that could have been used by aquatic organisms for homes?

- A. Oxygen
- B. High TSS
- C. Settling sediments
- D. Suspended sediment

349. Which of the following can include a wide variety of material, such as silt, decaying plant and animal matter, industrial wastes, and sewage?

- A. Total Solids
- B. TDS
- C. Total Suspended solids
- D. Alkalinity

350. Which of the following can block light from reaching submerged vegetation?

- A. Oxygen
- B. High TSS
- C. Settling sediments
- D. Suspended sediment

351. Wastewater treatment plants are designed to function as "microbiology farms," where bacteria and other microorganisms are fed oxygen and organic waste.

- A. True
- B. False

352. If light is completely blocked from bottom dwelling plants, the plants will stop producing oxygen and will die.

- A. True
- B. False

Settleometer Test

353. A simple procedure called the Settleometer Test is used to determine the settling characteristics of mixed liquor.

- A. True
- B. False

354. It is a good idea to occasionally record the MLSS concentration volume every 5 minutes while the flocs are settling and prepare a graph of settled activated sludge versus minutes. This allows the operator to see whether bugs are settling too quickly or slowly.

- A. True B. False

355. Mix the sample well, and fill the settleometer to the 1000 graduation. Immediately start a timer and at the end of 10 minutes record the solids volume in the settleometer.

- A. True B. False

356. The test requires a settleometer, which is typically a clear plastic cylinder with a capacity of 2 liters. Graduations on the cylinder range from 100 to 1000 cubic centimeters (or milliliters) of Settled sludge per liter.

- A. True B. False

357. A sample of nitrates should be obtained from the discharge end of the aeration tank, being careful not to include scum in the sampling container.

- A. True B. False

358. Do not allow the sample to set for more than a few minutes before the settling test is performed. Determine the _____ in milligrams per liter on a portion of this sample.

- A. MLSS concentration C. Nitrates
B. The solids D. None of the Above

359. Solids that settle too quickly may be an indication of _____ that will probably leave straggler floc in the effluent, while solids that settle too slowly or do not compact well may be washed out of the clarifier during times of high hydraulic load.

- A. Settled sludge C. Sludge volume
B. An old sludge D. None of the Above

Disinfection Section

Chlorine's Appearance and Odor

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

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

361. Prolonged exposures to chlorine gas may result in?

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

Reactivity

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

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

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

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

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

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

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

- A. Air
- B. Moisture, steam, and water
- C. Hydrogen sulfide
- D. None of the Above

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

- A. True
- B. False

Flammability

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

- A. True
- B. False

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

- A. True
- B. False

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

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

370. Chlorine may not be available for disinfection because _____ in the water (like iron, manganese, hydrogen sulfide, and ammonia).

- A. pH increases
- B. Part of it combines with other chemicals
- C. Required contact time
- D. None of the Above

371. The amount of chlorine required to achieve disinfection and that reacts with the other chemicals is the?

- A. Chlorine residual
- B. Chlorine demand
- C. Free chlorine residual
- D. None of the Above

372. Which term is used when disinfection decreases, as the concentration of the chlorine increases?

- A. pH increases
- B. Chlorine level and water quality
- C. Required contact time
- D. None of the Above

373. Chlorination is more effective as?

- A. Water temperature increases
- B. Chlorine demand
- C. Water cools down
- D. None of the Above

374. Chlorination becomes more alkaline and is less effective as the?

- A. Water's pH increases
- B. Water quality increases
- C. Required contact time is maximized
- D. None of the Above

375. Chlorination is less effective in?
A. Clear water C. Day time
B. Cloudy (turbid) water D. None of the Above

376. By adding a little more chlorine to what is already sufficient, this action will generally result in _____ that can be measured easily.
A. pH increases C. Required contact time
B. A free chlorine residual D. None of the Above

Chlorination Chemistry

377. The hypochlorite ion is a much weaker disinfecting agent than Hypochlorous acid, about 100 times less effective.

A. True B. False

378. Under normal water conditions, hypochlorous acid will also chemically react and break down into the hypochlorite ion.

A. True B. False

379. The disassociation of chlorine gas
(OCI -): HOCl H⁺ + OCl⁻ Also expressed HOCl → H⁺ + OCl⁻
(hypochlorous acid) (hydrogen) (hypochlorite ion)

A. True B. False

380. All three forms of chlorine produce Sodium hypochlorite when added to water.

A. True B. False

381. Hypochlorous acid is a strong acid but a weak disinfecting agent. The amount of hypochlorous acid depends on the pH and temperature of the water.

A. True B. False

382. According to the text, pH and temperature affect the ratio of hypochlorous acid to hypochlorite ions. As the temperature is decreased, the _____ increases.

A. Reduction Ratio C. "CT" disinfection concept
B. Ratio of hypochlorous acid D. None of the Above

383. Although the ratio of _____ is greater at lower temperatures, pathogenic organisms are actually harder to kill.

A. Hypochlorous acid C. Total chlorine
B. The amount of chlorine D. None of the Above

384. If all other things were equal, _____ and a lower pH are more conducive to chlorine disinfection.

A. Lower pH C. Higher water temperatures
B. Hypochlorous acid D. None of the Above

Alternative Disinfectants Sub-Section

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

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

386. In the production of _____, the ammonia residuals in the finished water, when fed in excess of stoichiometric amount needed, should be limited to inhibit growth of nitrifying bacteria.
- A. Dry sodium chlorite
 - B. Chloramines
 - C. Ammonia residual(s)
 - D. None of the Above

Chlorine Dioxide

387. Which term provides good Giardia and virus protection but its use is limited by the restriction on the maximum residual of 0.5 mg/L ClO₂/chlorite/chlorate allowed in finished water?
- A. Chlorinated byproducts
 - B. Chlorine dioxide
 - C. Ammonia residual(s)
 - D. None of the Above

388. If chlorine dioxide is being used as an oxidant, the preferred method of generation is to entrain this term or substance into a packed reaction chamber with a 25% aqueous solution of sodium chlorite (NaClO₂).
- A. Chloramine
 - B. Chlorine gas
 - C. Chlorine dioxide
 - D. None of the Above

389. According to the text, which chemical is explosive and can cause fires in feed equipment if leaking solutions or spills are allowed to dry out?
- A. Dry sodium chlorite
 - B. Chlorine dioxide
 - C. Ammonia
 - D. None of the Above

390. Chlorine dioxide may be used for either taste or odor control or as a?
- A. Chloramine
 - B. Pre-disinfectant
 - C. Gas
 - D. None of the Above

391. Total residual oxidants (including chlorine dioxide and chlorite, but excluding Chlorine dioxide) shall not exceed 0.50 mg/L during normal operation or 0.30 mg/L (including chlorine dioxide, chlorite and chlorate) during periods of extreme variations in the raw water supply.
- A. True
 - B. False

392. Which of the following means the addition of chlorine at the plant headworks or prior to other water treatment or groundwater production processes and mainly used for disinfection and control of tastes, odors, and aquatic growths?
- A. Post-chlorination
 - B. Pre-chlorination
 - C. Breakpoint chlorination
 - D. None of the Above

393. Which of the following means the addition of chlorine after a process or adding chlorine downstream to meet a demand in the system?
- A. Post-chlorination
 - B. Pre-chlorination
 - C. Breakpoint chlorination
 - D. None of the Above

394. Which of the following means the residual chlorine existing in water in chemical combination with ammonia or organic amines that can be found in natural or polluted waters?
- A. Combined chlorine
 - B. Pre-chlorination
 - C. Breakpoint chlorination
 - D. None of the Above

395. Which of the following means adding Cl_2 to the water until the Cl_2 demand is satisfied. Until all the microorganisms are killed?

- A. Post-chlorination
- B. Pre-chlorination
- C. Breakpoint chlorination
- D. None of the Above

Ozone

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

- A. True
- B. False

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

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

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

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

399. Ozone does not produce chlorinated byproducts (such as trihalomethanes) but it may cause an increase in such byproduct formation if it is fed ahead of free chlorine; ozone may also produce its own oxygenated byproducts such as $\text{Cl}_2 + \text{NH}_4$.

- A. True
- B. False

400. Ozonation must include adequate ozone leak detection alarm systems and an ozone off-gas destruction system.

- A. True
- B. False