

Registration form

**WWT 404 TRAINING COURSE \$250.00
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*

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

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

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

Wastewater Treatment _____ Other _____

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

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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 fully understand that this type of study program deals with dangerous, changing conditions and various laws and that I will not hold Technical Learning College, Technical Learning Consultants, Inc. (TLC) liable in any fashion for any errors, omissions, advice, suggestions or neglect contained in this CEU education training course or for any violation or injury, death, neglect, damage or loss of your license or certification caused in any fashion by this CEU education training or course material suggestion or error or my lack of submitting paperwork. It is my responsibility to 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. It is my responsibility to ensure all information is correct and to abide with all rules and regulations.

State Approval Listing Link; Check to see if your State or Agency 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 or agencies will accept our courses for credit but we do not officially list the States or Agencies. Please check your State for approval.

State Approval Listing URL...

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

You can obtain a printed version of the course from TLC for an additional \$99.95 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.

WWT 404 CEU Course Answer Key

Name _____

Telephone # _____

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

Method of Course acceptance confirmation. Please fill this section

Website ___ Telephone Call ___ Email ___ Spoke to _____

Did you receive the approval number, if applicable? _____

What is the course approval number, if applicable? _____

*You are responsible to ensure that TLC receives the Assignment and Registration Key.
Please call us to ensure that we received it.*

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

*Please circle, underline, bold or X only one correct answer
A felt tipped pen works best*

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| 1. A B | 17. A B C D | 33. A B C D | 49. A B |
| 2. A B | 18. A B C D | 34. A B C D | 50. A B |
| 3. A B | 19. A B C D | 35. A B C D | 51. A B C D |
| 4. A B | 20. A B | 36. A B C D | 52. A B C D |
| 5. A B | 21. A B | 37. A B C D | 53. A B C D |
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| 65. A B | 97. A B | 129. A B C D | 161. A B C D |
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| 67. A B | 99. A B | 131. A B | 163. A B |
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| 73. A B C D | 105. A B | 137. A B | 169. A B |
| 74. A B C D | 106. A B C D | 138. A B | 170. A B |
| 75. A B C D | 107. A B C D | 139. A B | 171. A B |
| 76. A B C D | 108. A B C D | 140. A B | 172. A B |
| 77. A B C D | 109. A B C D | 141. A B | 173. A B |
| 78. A B C D | 110. A B C D | 142. A B | 174. A B |
| 79. A B C D | 111. A B C D | 143. A B | 175. A B |
| 80. A B C D | 112. A B C D | 144. A B | 176. A B |
| 81. A B C D | 113. A B C D | 145. A B | 177. A B C D |
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| 87. A B C D | 119. A B C D | 151. A B | 183. A B C D |
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| 91. A B C D | 123. A B C D | 155. A B C D | 187. A B C D |
| 92. A B C D | 124. A B C D | 156. A B C D | 188. A B C D |
| 93. A B C D | 125. A B C D | 157. A B | 189. A B C D |
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| 95. A B C D | 127. A B C D | 159. A B | 191. A B |
| 96. A B C D | 128. A B C D | 160. A B | 192. A B |

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| 195. A B C D | 227. A B C D | 259. A B | 291. A B |
| 196. A B C D | 228. A B C D | 260. A B | 292. A B C D |
| 197. A B | 229. A B C D | 261. A B C D | 293. A B |
| 198. A B | 230. A B C D | 262. A B C D | 294. A B C D |
| 199. A B | 231. A B C D | 263. A B C D | 295. A B C D |
| 200. A B C D | 232. A B C D | 264. A B C D | 296. A B C D |
| 201. A B C D | 233. A B C D | 265. A B C D | 297. A B |
| 202. A B C D | 234. A B | 266. A B C D | 298. A B |
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| 204. A B C D | 236. A B C D | 268. A B C D | 300. A B |
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| 209. A B C D | 241. A B | 273. A B C D | 305. A B C D |
| 210. A B C D | 242. A B | 274. A B C D | 306. A B C D |
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| 218. A B | 250. A B | 282. A B C D | 314. A B C D |
| 219. A B | 251. A B | 283. A B | 315. A B C D |
| 220. A B C D | 252. A B C D | 284. A B | 316. A B C D |
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| 460. A B C D | 473. A B | 486. A B | 499. A B C D |
| 461. A B C D | 474. A B C D | 487. A B C D | 500. A B C D |

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

**Please fax the answer key to TLC
(928) 272-0747**

Always call to confirm that we received your paperwork.

This course contains general EPA's CWA federal rule requirements. Please be aware that each state implements wastewater/safety/environmental /building regulations that may be more stringent than EPA's regulations. Check with your state environmental/health agency for more information. These rules change frequently and are often difficult to interpret and follow. Be careful to be in compliance and do not follow this course for proper compliance.

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

**WWT 404
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.

Please rate the difficulty of your course.

Very Easy 0 1 2 3 4 5 Very Difficult

Please rate the difficulty of the testing process.

Very Easy 0 1 2 3 4 5 Very Difficult

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

Very Similar 0 1 2 3 4 5 Very Different

How did you hear about this Course? _____

What would you do to improve the Course?

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.

WWT 404 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.

You will have 90 days from the start of this course 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 email all concerns and the completed manual to info@tlch2o.com.

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.

Wastewater Introduction

Primary Wastewater Components and Constituents

1. 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
2. Oxidation is the addition of hydrogen, removal of oxygen or addition of electrons to an element or compound.
A. True B. False
3. Anaerobic- a condition in which “free” or dissolved oxygen is not present in the aquatic environment.
A. True B. False
4. Saprophytic bacteria thrive without the presence of oxygen.
A. True B. False
5. Anaerobic Bacteria that break down complex solids to volatile acids.
A. True B. False
6. Aerobic is a condition in which free or dissolved oxygen is present in the aquatic environment.
A. True B. False
7. Aerobic Bacteria will live and reproduce only in an environment containing oxygen.
A. True B. False
8. When oxygen chemically combined, such as in water molecules can be used for respiration by aerobes
A. True B. False
9. Methane Fermenters – bacteria that break down the volatile acids to methane, carbon dioxide and water.
A. True B. False

10. Under aerobic conditions in wastewater, sulfur compounds or elemental sulfur are reduced to H₂S or sulfide ions.
A. True B. False

Biological

11. 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

Organic Matter

12. 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

13. 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. Many synthetic organic compounds
B. Organic material(s) D. None of the Above

14. Which of the following are toxic to humans, fish, and aquatic plants and often are disposed of improperly in drains or carried in stormwater?
A. Nitrogen and phosphorus C. Pesticides and herbicide(s)
B. Turbidity D. None of the Above

15. 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

16. Large amounts of biodegradable materials can reduce or deplete the _____ in the water needed by aquatic life.
A. Carbon Dioxide C. Nutrients
B. Supply of oxygen D. None of the Above

Oil and Grease

17. Which of the following also adds to the septic tank scum layer, causing more frequent tank pumping to be required?
A. Nutrients from wastewater C. Excessive grease
B. Inorganic materials D. None of the Above

18. Which of the following used for motors and industry are considered hazardous waste and should be collected and disposed of separately from wastewater?
A. Nitrogen and phosphorus C. Petroleum-based waste oil(s)
B. Inorganic substances D. None of the Above

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

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

20. 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

Inorganics

21. 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

22. Less than normal amount 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

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. 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

25. 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

26. 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

27. 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

28. 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

29. Laboratory prepared bugs are more efficient in organics removal if they have the right growth environment; this efficiency is multiplied if microorganisms are allowed to grow.

- A. True B. False

Pretreatment Section

30. Which of the following results in the presence of toxic gases, vapors, or fumes within the POTW in a quantity that may cause acute worker health and safety problems?

- A. Categorical pretreatment standards C. Violation of the general prohibitions
B. Discharge(s) D. None of the Above

31. Which of the following except at discharge points designated by the POTW?

- A. Interference or pass through C. Discharges of trucked or hauled pollutants
B. Discharge or discharges D. None of the Above

32. Specific prohibitions forbid eight categories of pollutant discharges as follows: Discharges containing pollutants which create a fire or explosion hazard in the CMOM, including but not limited to, wastestreams with a closed cup flashpoint of more than 140°F using the test methods specified in 40 CFR §261.21.

- A. True B. False

33. Discharges containing pollutants causing corrosive structural damage to the POTW, but in no case discharges with a pH lower than 5.0, unless the POTW is specifically designed to accommodate such?

- A. Categorical pretreatment standards C. Violation of the general prohibitions
B. Discharge(s) D. None of the Above

34. Which of the following containing pollutants in amounts causing obstruction to the flow in the POTW resulting in interference?

- A. Interference or pass through C. Categorical pretreatment standards
B. Discharges D. None of the Above

35. Which of the following of any pollutants released at a flow rate and/or concentration which will cause interference with the POTW?

- A. Discharge(s) C. Violation of the general prohibitions
B. Pass through D. None of the Above

36. Discharges of petroleum oil, non-biodegradable cutting oil, or products of mineral oil origin in amounts that will cause?

- A. Interference or pass through C. Eight categories of pollutant discharges
B. Discharge or discharges D. None of the Above

Categorical Standards

37. Categorical pretreatment standards are national, uniform, technology-based standards that apply to discharges to POTWs from specific industrial categories and limit the?

- A. Categorical pretreatment standards
- B. Pass through
- C. Discharge of specific pollutants
- D. None of the Above

38. Which of the following for both existing and new sources (are promulgated by the EPA pursuant to Section 307(b) and (c) of the CWA?

- A. Flow rate and/or concentration
- B. Pass through
- C. Categorical pretreatment standards
- D. None of the Above

FOG Introduction

Controlling Fats, Oils, and Grease Discharges from Food Service Establishments

39. Commercial food preparation establishments with inadequate grease controls is the primary method that FOG gets into our sewer collection system mainly from _____pouring the substances down their drains.

- A. CSO/SSO
- B. POTWs
- C. Residential customers
- D. None of the Above

40. Sewer backups and overflows on streets, properties and even in customers' homes and/or businesses are caused because of improper disposal of fats, oils and grease, FOG builds up in the _____ and eventually block collection pipes and sewer lines, resulting in

- A. Sewer system
- B. POTW's requirement(s)
- C. Least management practices (LMPs)
- D. None of the Above

41. Ponds, streams or rivers will be contaminated due to _____ and will also impact the environment negatively.

- A. Overflow(s)
- B. FOG
- C. POTW Commercial FOG Program(s)
- D. None of the Above

Food Service Establishments (FSEs)

42. The _____ can handle properly disposed wastes, but to work effectively, sewer systems need to be properly maintained, from the drain to the treatment plant.

- A. POTW's sewer system
- B. POTW's requirement(s)
- C. Most management practices (MMPs)
- D. None of the Above

43. Various businesses and individuals to need to be responsible in maintaining the POTW system because repeated repairs are disruptive to residences and businesses alike. Proper sewer disposal by commercial establishments is required by _____.

- A. Law
- B. POTW's recommendations
- C. Best management advice (BMAs)
- D. None of the Above

44. Because of the amount of grease used in cooking, _____are a significant source of fats, oil and grease (FOG).

- A. Sewer system infiltration
- B. POTW's requirement(s)
- C. Food Service Establishments (FSEs)
- D. None of the Above

45. To assist improper handling and disposal of their FOG _____ are generally developed to assist restaurants and other FSEs with instruction and compliance.

- A. CSO/SSO
- B. POTWs
- C. POTW Commercial FOG Program
- D. None of the Above

Environmental problem with FOG sewers

46. Grease balls are formed by _____ that enters the sewer system eventually solidifies.

- A. FOG
- B. Sewer backup(s)
- C. Solids
- D. None of the Above

47. The POTW collection system(s) will require that certain food service establishments install interceptor/collector devices (e.g., grease traps) in order to accumulate grease on-site and prevent it from entering the?

- A. Kitchen drain(s)
- B. Interceptor/collector device(s)
- C. POTW collection system(s)
- D. None of the Above

Residential and Commercial Guidelines

48. The major concern for _____ is the improper disposal of fats, oil and grease (FOG) found in food ingredients such as meat, cooking oil, shortening, butter, margarine, baked goods, sauces and dairy products.

- A. CSO/SSO
- B. POTW's sewers
- C. Customer service
- D. None of the Above

Primary Wastewater Treatment Section

Conventional A/S Wastewater Treatment Plant Overview

Primary Treatment

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

- A. True
- B. False

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

- A. True
- B. False

51. 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

52. 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

Preliminary Treatment

53. 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

54. 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

55. 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

56. 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

57. 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

58. 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

Primary Sedimentation

59. 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

60. 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

61. 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

62. 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

Temperature

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

- A. True
- B. False

64. 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

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

- A. True
- B. False

66. pH indicates increasing acidity while a low pH indicates increasing alkalinity.
A. True B. False

Secondary Treatment Section

Secondary Treatment

67. 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

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

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

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

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

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

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

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

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

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

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

Raw Water Screening

73. 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 C. Compacted clay bottoms and sides
B. Series or in parallel D. None of the above

74. Microorganisms in the first two ponds treat the incoming effluent, while the third 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 C. Compacted clay bottoms and sides
B. A quiet zone D. None of the above

75. Ponds generally do not have a secondary clarifier, the _____ fulfils the clarifier action.

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

Pond Lining

76. 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

77. 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

78. Aerobic BOD removal generally proceeds well from pH 6.5 to 9.0 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

79. 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

80. 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

81. 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

82. 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 +200 m V.

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

Lagoon Systems

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

- A. True
- B. False

84. 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

85. Swimming and _____ engulf bacteria or other prey.

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

86. 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

87. Predators feed mostly on stalked and _____.

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

88. 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

89. Food (organic loading) regulates _____?

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

Lagoon Microorganisms Introduction

90. 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

91. 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

92. 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

93. 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

94. 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

95. 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

96. 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

97. 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

98. 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

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

- A. True
- B. False

Mixed or Suspended Lagoons

100. 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

101. 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

102. 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)
- B. Anaerobic decomposition
- C. Dissolved organic and inorganic constituents
- D. None of the Above

Advanced Methods of Wastewater Treatment

103. 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
- B. Some contaminants
- C. Soluble nutrients
- D. None of the Above

104. All WWTPs provide a minimum of?

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

Advanced Treatment Technologies

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

- A. True B. False

106. 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

107. 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

108. 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

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

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

110. 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

111. 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

112. 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

113. 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

114. In nearly all activated sludge plants, wasting is accomplished by directing a portion of the Return Sludge to the _____.

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

115. Wasting Return Sludge rather than _____ minimizes the volume of water that must be processed by the sludge thickening/dewatering equipment.

- A. Mixed Liquor
- B. CRT
- C. RAS
- D. None of the above

116. 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
- B. Solids handling process
- C. Many activated sludge plants
- D. None of the above

117. 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
- B. Biological system
- C. Advanced system
- D. None of the above

118. Consistency is a key element in successful _____ operation.

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

119. 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
- B. Heavier primary solids
- C. Scum
- D. None of the above

120. 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

121. 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

122. 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

123. 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

124. 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

125. 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

Sludge Settling

126. 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

127. 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

128. Waste activated sludge also determines the _____.

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

Organic Load

129. 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
- B. High degradation rate
- C. Flocculating
- D. None of the Above

130. 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

131. 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

132. 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

Excess Solids

133. 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)

134. 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

Sludge Age

135. 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

136. 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

Constant MLSS (Mixed Liquor Suspended Solids)

137. 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

138. 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 thicker waste activated sludge (high WAS concentration).

A. True B. False

Clarifier Sludge Blanket

139. 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

140. 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

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

A. True B. False

Pin Floc

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

- A. True B. False

Stable Nitrification

143. 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

144. 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

145. 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

Bacteria and Temperature Effect

146. 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

Extended Aeration Activated Sludge Plants

147. 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

Clarifier Sludge Blanket

148. 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

149. 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

150. 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

151. 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

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

- A. True B. False

Denitrification in Final Clarifier

153. 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

Old Sludge

154. 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

Denitrification

155. 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)

156. 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

Nutrient Section

TKN

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

- A. True B. False

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

A. True B. False

159. 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

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

A. True B. False

Ammonia

161. 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

162. 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

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

A. True B. False

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

A. True B. False

165. 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

Nitrifying Bacteria

166. 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

167. 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 (CO_2) as a food source.

A. True B. False

Significant Amount of Oxygen

168. 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

169. 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

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

A. True B. False

Total Inorganic Nitrogen (TIN)

171. 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

172. 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

173. 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

174. 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

175. 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

176. 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

177. _____ 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

C. Soluble biodegradable phosphorus

B. Phosphorus

D. Particulate organically bound phosphorus

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

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

179. _____ 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

180. 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

181. 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)

182. 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

Biological Phosphorus Control

183. 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)

184. 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

185. 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

186. 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

187. 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

188. 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

189. 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

190. 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

191. 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

192. 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

193. 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

194. 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)

195. 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

196. 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

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

- A. True
- B. False

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

- A. True
- B. False

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

- A. True
- B. False

200. 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

201. 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

202. Complete nitrification would be expected at pond pH values between pH 7.0 and 8.5.

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

203. 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

204. 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

205. 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

206. Anaerobic methane formation involves _____ bacteria.

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

207. 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

Photosynthetic Organisms

208. 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

209. 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

210. 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

211. 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

212. 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

213. 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

214. 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

215. 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

216. 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

217. 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

218. 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

Nutrient Constituents in Wastewater and Measurement Methods

Nitrogen

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

- A. True
- B. False

220. 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

221. 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

222. 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:

223. Digestion to convert organic nitrogen to?

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

224. 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

225. 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

226. Nitrogen components in wastewater are typically reported on an "_____” basis?

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

227. 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

228. 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

229. 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

230. 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

231. 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

232. 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

233. 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

234. 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

235. 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

236. 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
- B. Application-specific bacteria
- C. Aerobic
- D. None of the Above

Anaerobic Bacteria

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

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

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

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

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

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

240. 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
- B. Absence of free oxygen
- C. Significantly higher quantity of bacteria
- D. None of the Above

Aerobic Bacteria

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

- A. True
- B. False

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

- A. True
- B. False

243. The metabolism of aerobes is much higher than?
A. Application-specific bacteria C. Aerobic bacteria
B. Anaerobes D. None of the Above

244. 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

245. 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

246. 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

247. Pleomorphic bacteria can assume a variety of shapes.
A. True B. False

248. 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

249. 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

250. 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

251. Shigellae are Gram-negative, non-spore-forming, facultatively anaerobic, Pleomorphic bacteria.
A. True B. False

Salmonella

252. 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

253. 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
- B. Fecal concentration
- C. Fecal coliform bacteria
- D. None of the Above

254. 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
- B. Fecal coliform
- C. Bacterial concentrations
- D. None of the Above

Protozoans and Metazoans

255. 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
- B. Macroinvertebrates
- C. Protozoans and metazoans
- D. None of the Above

256. 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

257. 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

258. 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

259. Dispersed growth is material suspended within the activated sludge process that has not been adsorbed into the floc particles.

- A. True
- B. False

260. Dispersed growth 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

261. 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.

262. 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

263. 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

264. 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

265. 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

266. 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

267. 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

268. 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

269. 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

270. 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

271. 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

272. 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

273. 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. Flocc
- C. Non-organic solids and biomass
- D. None of the Above

274. 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

275. 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

276. 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.

277. 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

278. 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.

279. 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

280. 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

281. 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.

282. Euchlanis is a typical?

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

283. 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

284. 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:

285. 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

286. 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

287. 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

Filamentous Organisms

288. 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

289. 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

290. 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

291. 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

292. Microthrix parvicella is another common cause of?

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

Sphaeroliticus natans

293. 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

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

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

Filamentous Bacteria

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

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

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

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

Biological Criteria Sub-Section

Water Quality Criteria

297. 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

298. 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

299. 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

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

- A. True B. False

Biological Criteria

301. 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

302. 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

303. 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

304. 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

305. 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

306. Pure water has a pH very close to?

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

307. _____ 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

308. 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

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

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

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

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

311. 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

312. 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

313. 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

314. 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

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

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

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

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

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

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

318. 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
- B. Colorwheel measurement
- C. Visual comparison
- D. None of the Above

319. 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

320. 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

321. 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

322. 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

323. 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

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

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

325. 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

326. 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

327. 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

328. Aerobic means without air and some bacteria thrive under these conditions and utilize the nutrients and chemicals available to exist.

A. True B. False

329. Aerobes decompose inorganics in the water; the result is carbon dioxide and H_2SO_4 .

A. True B. False

330. Dissolved oxygen (DO) in water is considered a contaminant.

A. True B. False

331. The saprophytes exist on dead or decaying materials.

A. True B. False

332. 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

333. Aerobic bacteria do not require oxygen to live and thrive.

A. True B. False

334. 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

335. 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

336. A lack of Dissolved oxygen in natural waters creates?

A. Anaerobic conditions C. Aerobic Conditions
B. Denitrification D. None of the Above

337. 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

338. Which of the following indicate that dissolved oxygen is present?

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

339. _____ 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

340. 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

341. 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

342. 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

343. 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

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

- A. True
- B. False

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

- A. True
- B. False

346. 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

347. 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

348. 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

349. 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

350. Which of the following is highly dependent on the source and characteristics of the sample?
A. Methods of analysis C. Aerobic conditions
B. DO analysis D. None of the Above

351. Which of the following passes through the membrane and measured by the meter?
A. Carbon dioxide C. Only molecular oxygen
B. Dissolved Oxygen D. None of the Above

352. Membrane electrodes provide an excellent method for _____ in polluted, highly colored turbid waters and strong waste effluents.
A. Sample(s) C. Aerobic conditions
B. DO analysis D. None of the Above

353. Proper samples must be taken in _____ bottles where agitation or contact with air is at a minimum.
A. BOD C. MLSS measurement
B. DO analysis D. None of the Above

354. Which of the following is the one of the most important analyses in determining the quality of natural waters?
A. Anaerobic conditions C. The dissolved oxygen test
B. Undissolved Oxygen D. None of the Above

355. Which of the following measurement is essential for adequate process control?
A. Dissolved oxygen C. Aerobic conditions
B. DO analysis D. None of the Above

Total Dissolved Solids

356. Pure water is tasteless, colorless, and odorless and is often called the universal solvent.
A. True B. False

357. Which of the following refers to any minerals, salts, metals, cations or anions dissolved in water?
A. Total Solids C. Total Suspended solids
B. TDS D. Dissolved solids

358. Which of the following comprise inorganic salts and some small amounts of organic matter that are dissolved in water?
A. Settleability C. Quality of the water
B. Total dissolved solids (TDS) D. Total Solids

359. The TDS test does not provide us insight into the specific water quality issues, such as: Elevated Hardness, Salty Taste, or?
A. Total Solids C. Corrosiveness
B. TDS D. Alkalinity

Total Solids

360. 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

361. 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

362. 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

363. 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

364. 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)

365. 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

366. 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

367. 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

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

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

369. 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

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

A. True B. False

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

A. True B. False

372. 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

Settleometer Test

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

A. True B. False

374. 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

375. 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

376. 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

377. 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

378. 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

379. 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

Advanced Wastewater Treatment Section

Advanced Treatment Section

Types of Processes

380. Wastewater treatment membrane technology is becoming increasingly important. With the help of _____ it is possible to remove particles, colloids and macromolecules, so that waste-water can be disinfected in this way.

- A. Ultra/microfiltration
- B. Fractional distillation
- C. Membrane technology
- D. None of the Above

381. Many azeotropic mixtures of pairs of compounds are known, and many azeotropes of three or more compounds are also known, it is not possible to separate the components by

- A. Ultra/microfiltration
- B. Fractional distillation
- C. Membrane technology
- D. None of the Above

382. Which of the following operate without heating and therefore use less energy than conventional thermal separation processes such as distillation, sublimation or crystallization?

- A. Cold separation
- B. Membrane separation processes
- C. Conventional thermal separation process(es)
- D. None of the Above

383. Which of the following uses membrane technology and is widely used in the food technology, biotechnology and pharmaceutical industries?

- A. Cold separation
- B. Membrane separation processes
- C. Conventional thermal separation process(es)
- D. None of the Above

384. According to the text, it is impossible to separate the constituents of azeotropic liquids or solutes which form isomorphous crystals by distillation or recrystallization but such separations can be achieved using _____.

- A. Membrane technology
- B. Macromolecule(s)
- C. Reverse osmosis
- D. None of the Above

385. Applications include the production of drinking water by _____ (worldwide approximately 7 million cubic meters annually), filtrations in the food industry, the recovery of organic vapors such as petro-chemical vapor recovery and the electrolysis for chlorine production.

- A. Membranes
- B. Macromolecule(s)
- C. Reverse osmosis
- D. None of the Above

Membrane Filtration Processes

386. Which of the following enables some water systems having contaminated water sources to meet new, more stringent regulations?

- A. Ultra/microfiltration
- B. Fractional distillation
- C. Membrane technology
- D. None of the Above

Description of Membrane Filtration Processes

387. Which of the following water is forced through a porous membrane under pressure, while suspended solid, large molecules or ions are held back or rejected?

- A. Ultra/microfiltration
- B. Fractional distillation
- C. Membrane processes
- D. None of the Above

Microfiltration

388. The current primary use of MF is by industries to remove very fine particles from process water, the process has also been used as a pretreatment for?

- A. Ultra/microfiltration
- B. Fractional distillation
- C. Other membrane processes
- D. None of the Above

389. RO membranes are susceptible to clogging or filter binding unless the _____ being processed is already quite clean.

- A. Process liquid
- B. Water
- C. Total dissolved solids (TDS)
- D. None of the Above

390. Which of the following has been proposed as a filtering method for particles resulting from the direct filtration process?

- A. Direct filtration process
- B. Potable water treatment
- C. Microfiltration or MF
- D. None of the Above

391. The use of filter aids to improve filtering efficiency, especially for small particles that could contain _____ are recommended.

- A. Total dissolved solids (TDS)
- B. Chloride and sodium
- C. Bacterial and protozoan life
- D. None of the Above

Ultrafiltration

392. The smaller pore size is designed to remove colloids and substances that have larger molecules, which are called?

- A. Equal to a certain molecular weight
- B. Microfiltration or MF
- C. High-molecular-weight materials
- D. None of the Above

393. UF membranes can be designed to pass material that weigh less than or?

- A. Equal to a certain molecular weight
- B. Microfiltration or MF
- C. High-molecular-weight materials
- D. None of the Above

394. UF does not generally work well for removal of _____, it can be used effectively for removal of most organic chemicals.

- A. Process liquid
- B. Total dissolved solids (TDS)
- C. Salt or dissolved solids
- D. None of the Above

Nanofiltration

395. Nanofiltration (NF) process has been used primarily for water softening and reduction of?

- A. Process liquid
- B. Total dissolved solids (TDS)
- C. Salt or dissolved solids
- D. None of the Above

396. NF capability will undoubtedly increase the use of _____ for potable water treatment.

- A. Reverse osmosis or RO
- B. NF
- C. Direct filtration process
- D. None of the Above

Reverse Osmosis

397. RO membranes have very low MWC pore size that can reject ions at very high rates, including?

- A. Chloride and sodium
- B. Total dissolved solids (TDS)
- C. Salt or dissolved solids
- D. None of the Above

398. RO also works most organic chemicals, and radionuclides and microorganisms. Industrial water uses such as semiconductor manufacturing is also an important?

- A. RO process
- B. Potable water treatment
- C. Direct filtration process
- D. None of the Above

Microfiltration Specific Process

399. Microfiltration is a type of physical filtration process where a contaminated fluid is passed through a special pore-sized membrane to separate microorganisms and suspended particles from?

- A. Chloride and sodium
- B. Process liquid
- C. Salt or dissolved solids
- D. None of the Above

400. Which of the following works with such as ultrafiltration and reverse osmosis to provide a product stream that is free of undesired contaminants?

- A. Various other separation processes
- B. MF membranes
- C. Batch or semi-continuous filtration
- D. None of the Above

401. Microfiltration usually serves as a pre-treatment for other separation processes such as?

- A. Cross flow filtration
- B. Filtration process(es)
- C. Ultrafiltration
- D. None of the Above

Common Applications

Water Treatment Process

402. Which of the following presents a physical means of separation (a barrier) as opposed to a chemical alternative?

- A. Fouling membranes
- B. MF membranes
- C. Batch or semi-continuous filtration
- D. None of the Above

403. Which of the following are used in secondary wastewater effluents to remove turbidity but also to provide treatment for disinfection?

- A. Cross flow filtration
- B. Filtration process(es)
- C. MF membranes
- D. None of the Above

Driving Force, Retentate Stream and Permeate Streams

404. Which of the following can be distinguished by three major characteristics; Driving force, retentate stream and permeate streams?

- A. Membrane filtration processes
- B. Retentate and product streams
- C. Batch or semi-continuous filtration
- D. None of the Above

405. Which of the following is pressure driven with suspended particles and water as retentate and dissolved solutes plus water as permeate?

- A. Cross flow filtration
- B. The use of hydraulic pressure
- C. Microfiltration process
- D. None of the Above

406. Which of the following accelerates the separation process by increasing the flow rate (flux) of the liquid stream but does not affect the chemical composition of the species in the retentate and product streams?

- A. Cross flow filtration
- B. The use of hydraulic pressure
- C. Microfiltration process
- D. None of the Above

Fouling

407. A major characteristic that limits the performance of microfiltration or any membrane technology is a process known as?

- A. Cross flow filtration
- B. Performance of microfiltration
- C. Fouling
- D. None of the Above

408. Which of the following describes the deposition and accumulation of feed components such as suspended particles, impermeable dissolved solutes or even permeable solutes, on the membrane surface and or within the pores of the membrane?

- A. Cross flow filtration
- B. Performance of microfiltration
- C. Fouling
- D. None of the Above

409. Fouling of the membrane during the filtration processes decreases the flux and thus overall efficiency of the operation. This is indicated when the pressure drop increases to a certain point. It occurs even when operating parameters are constant (pressure, flow rate, temperature and concentration)

- A. True
- B. False

Nanofiltration (NF) Section

410. Which of the following are controlled by pH, temperature and time during development with pore densities ranging from 1 to 10⁶ pores per cm²?

- A. Simultaneous concentration
- B. Pore dimensions
- C. Natural organic matter and synthetic organic matter
- D. None of the Above

411. Membranes made from polyethylene terephthalate are referred to as _____, named after the way the pores on the membranes are made.

- A. Ultrafiltration
- B. Track-etch" membrane(s)
- C. Direct filtration process
- D. None of the Above

412. Nanofiltration is a relatively recent membrane filtration process used most often with low total dissolved solids water with the purpose of softening (polyvalent cation removal) and removal of _____ such as natural organic matter and synthetic organic matter.

- A. Process liquid
- B. Chloride and sodium
- C. Disinfection by-product precursors
- D. None of the Above

413. Nanofiltration is also becoming more widely used in food processing applications and for _____ and partial (monovalent ion) demineralization.

- A. Simultaneous concentration
- B. Pore dimensions
- C. Natural organic matter and synthetic organic matter
- D. None of the Above

414. Which of the following is a membrane filtration-based method that uses nanometer sized cylindrical through-pores that pass through the membrane at 90°?

- A. Reverse osmosis or RO
- B. Nanofiltration
- C. Direct filtration process
- D. None of the Above

415. Nanofiltration membranes have pore sizes from 1-10 nanometers, smaller than that used in microfiltration and?

- A. Ultrafiltration
- B. Track-etch" membrane(s)
- C. Direct filtration process
- D. None of the Above

416. "Tracking" results in making tracks that are chemically developed into the membrane or _____ into the membrane, which are the pores.

- A. Gentle molecular separation
- B. Tracking
- C. "Etched"
- D. None of the Above

417. According to the text, membranes created from metal such as _____, are made by electrochemically growing a thin layer of aluminum oxide from aluminum metal in an acidic medium.

- A. Solvent-stable membrane(s)
- B. Membrane(s)
- C. Alumina membranes
- D. None of the Above

Range of Applications

418. The original uses for nanofiltration were water treatment and?

- A. Gentle molecular separation
- B. Solvent-stable membrane(s)
- C. Water softening
- D. None of the Above

419. Which of the following can "soften" water by retaining scale-forming, hydrated divalent ions (e.g. Ca^{2+} , Mg^{2+}) while passing smaller hydrated monovalent ions?

- A. Track-etch" membrane(s)
- B. Membrane(s)
- C. Nanofilter(s)
- D. None of the Above

420. Which of the following has allowed the application for nanofiltration membranes to extend into new areas such as pharmaceuticals, fine chemicals, and flavor and fragrance industries?

- A. Solvent-stable membrane(s)
- B. Membrane(s)
- C. Alumina membranes
- D. None of the Above

421. Organic solvent nanofiltration technology and _____ used has extended possibilities for applications in a variety of organic solvents ranging from non-polar through polar to polar aprotic.

- A. Solvent-stable membrane(s)
- B. Membrane(s)
- C. Commercialization of membranes
- D. None of the Above

Advantages and Disadvantages

422. Which of the following do not operate at room temperature (e.g. distillation), which greatly increases the cost of the process when continuous heating or cooling is applied?

- A. Many separation processes
- B. Gentle molecular separation
- C. Organic solvent nanofiltration technology
- D. None of the Above

423. Which of the following is linked with nanofiltration that is often not included with other forms of separation processes (centrifugation)?

- A. Many separation processes
- B. Gentle molecular separation
- C. Organic solvent nanofiltration technology
- D. None of the Above

424. Which of the following has a very favorable benefit of being able to process large volumes and continuously produce streams?

- A. Ultrafiltration
- B. Microfiltration or MF
- C. Nanofiltration
- D. None of the Above

425. Anything smaller, reverse osmosis is used and anything larger is used for?

- A. Ultrafiltration
- B. Microfiltration or MF
- C. Nanofiltration
- D. None of the Above

426. Which of the following can also be used in cases where nanofiltration can be used, due to it being more conventional?

- A. Ultrafiltration
- B. Microfiltration or MF
- C. Nanofiltration
- D. None of the Above

427. Which of the following membranes are an expensive part of the process. Repairs and replacement of membranes is dependent on total dissolved solids, flow rate and components of the feed?

- A. Ultrafiltration
- B. Microfiltration or MF
- C. Nanofiltration
- D. None of the Above

428. Which of the following being used across various industries, only an estimation of replacement frequency can be used?

- A. Ultrafiltration
- B. Microfiltration or MF
- C. Nanofiltration
- D. None of the Above

429. One of the main advantages of nanofiltration as a method of softening water is that during the process of retaining calcium and magnesium ions while passing smaller hydrated monovalent ions, filtration is performed without adding extra sodium ions, as used in ion exchangers.

- A. True
- B. False

Reverse Osmosis Process Section

430. Osmosis is a natural phenomenon in which a liquid - water in this case - passes through a semi-permeable membrane from a relatively dilute solution toward a more concentrated solution. This flow produces a measurable pressure, called osmotic pressure.

- A. True
- B. False

431. Which of the following produces high quality water at low cost compared to other purifications processes?

- A. Ultrafiltration
- B. Microfiltration or MF
- C. RO
- D. None of the Above

432. Which of the following is determined by the total dissolved solids content of the saline solution, or contaminated solution on one side of the membrane?

- A. Pressure differential
- B. Osmotic pressure
- C. Virtually 100% of colloidal and suspended matter
- D. None of the Above

433. The higher the content of dissolved solids, the higher the?
 A. Pressure differential C. Virtually 100% of colloidal and suspended matter
 B. Osmotic pressure D. None of the Above
434. Which of the following result in higher osmotic pressures?
 A. Pressure differential C. Higher molecular weights
 B. Osmotic pressure D. None of the Above
435. According to the text, common tap water as found in most areas may have an osmotic pressure of about 10 PSI (Pounds per Square Inch), or about?
 A. 376 PSI C. 1.68 Bar
 B. A pressure of 10 PSI D. None of the Above
436. According to the text, Seawater at _____ typically has an osmotic pressure of about 376 PSI (26.75 Bar).
 A. 36,000 PPM C. 1.68 Bar
 B. A pressure of 10 PSI D. None of the Above
437. To reach the point at which osmosis stops for tap water, a pressure of 10 PSI would have to be applied to the saline solution, and to stop osmosis in seawater, a pressure of _____ would have to be applied to the seawater side of the membrane.
 A. 376 PSI C. 1.68 Bar
 B. A pressure of 10 PSI D. None of the Above

Brine Channel

438. Concentrated raw water is called the reject stream or concentrate stream, it may also be called brine if it is coming from a?
 A. Salt water source C. The concentrate
 B. Microporous support layer D. None of the Above
439. Each sheet of membrane material is inspected at special light tables to ensure the quality of the membrane coating, before being assembled into the?
 A. Spiral wound element design C. Amount of permeate or product water
 B. Microporous support layer D. None of the Above
440. To achieve Reverse Osmosis, the _____ pressure is generally doubled.
 A. Membrane material C. Amount of permeate or product water
 B. Osmotic D. None of the Above
441. Which of the following when sufficient flows are maintained, serves to carry away the impurities removed by the membrane, thus keeping the membrane surface clean and functional?
 A. Salt water source C. The concentrate
 B. Microporous support layer D. None of the Above
442. The membrane material itself is a special thin film composite (TFC) polyamide material, cast in a microscopically thin layer on another, thicker cast layer of Polysulfone called?
 A. Salt water source C. The concentrate
 B. Microporous support layer D. None of the Above

443. The inverse occurs with lower temperatures, in that salt passage decreases (reducing the _____ in the permeate or product water), while operating pressures increase. Or, if operating pressures do not increase, then the amount of permeate or product water is reduced.

- A. TDS
- B. Raw water
- C. Concentrate
- D. None of the Above

444. The rejection rate is the percentage of _____ rejected, or prevented from passing through the membrane.

- A. Percentage of permeate
- B. Raw water
- C. Dissolved solids
- D. None of the Above

445. A membrane with a rejection rate of 99% (usually based on Na (Sodium)) will allow only 1% of the concentration of _____ to pass through into the permeate.

- A. Percentage of permeate
- B. Raw water
- C. Dissolved solids
- D. None of the Above

446. As the raw water is processed, the concentrations of _____ increase as it passes along the membrane's length and usually multiple membranes are employed, with each membrane in series seeing progressively higher dissolved solids levels.

- A. Percentage of permeate
- B. Raw water
- C. TDS
- D. None of the Above

447. Typically, starting with seawater of 36,000 PPM, standard rejection membranes produce?

- A. Permeate above 500 PPM
- B. Permeate below 500 PPM
- C. Amount of permeate or product water
- D. None of the Above

448. Optimum flows and pressures, optimum recovery rates (the _____ from a given stream of raw water), prefiltration and other pretreatment considerations, and so forth.

- A. Percentage of permeate
- B. Multi-media filtration
- C. Amount of permeate or product water
- D. None of the Above

449. Well-designed systems employ multiple stages of prefiltration, tailored to the application, including _____ and one or more stages of cartridge filtration.

- A. Percentage of permeate
- B. Multi-media filtration
- C. Amount of permeate or product water
- D. None of the Above

450. Which of the following has proved to be the most reliable and cost effective method of desalinating water, and hence its use has become more and more widespread?

- A. Reverse Osmosis
- B. Potable water treatment
- C. Direct filtration process
- D. None of the Above

451. Which of the following is usually some 70% less than for comparable evaporation technologies?

- A. Energy consumption
- B. Component parts
- C. Direct filtration process
- D. None of the Above

452. Which of the following have been improved as well, reducing maintenance and down time?

- A. Each sheet of membrane material
- B. Microporous support layer
- C. Component parts
- D. None of the Above

453. Which of the following delivers product water or permeate having essentially the same temperature as the raw water source?

- A. Reverse Osmosis
- B. Potable water treatment
- C. Direct filtration process
- D. None of the Above

454. R/O Systems can be designed to deliver virtually any?

- A. Required product water quality
- B. Microporous support layer
- C. Amount of permeate or product water
- D. None of the Above

455. Reverse osmosis, also known as?

- A. Hyperfiltration
- B. Microfiltration or MF
- C. Direct filtration process
- D. None of the Above

456. Reverse osmosis is used to purify water and remove salts and other impurities in order to improve the color, taste, or properties of the?

- A. Cross-flow
- B. Concentrate
- C. Fluid
- D. None of the Above

457. RO can be used to purify fluids such as ethanol and glycol, which will pass through the reverse osmosis membrane, while rejecting?

- A. Percentage of permeate
- B. Raw water
- C. Ions and contaminants
- D. None of the Above

458. RO is used to produce _____ that are currently in place.

- A. Permeate
- B. Concentrate
- C. Water that meets the most demanding specifications
- D. None of the Above

459. Reverse osmosis technology uses a process known as _____ to allow the membrane to continually clean itself.

- A. Cross-flow
- B. Concentrate
- C. Fluid
- D. None of the Above

460. Which of the following passes through the membrane the rest continues downstream, sweeping the rejected species away from the membrane?

- A. Some of the fluid
- B. The higher the pressure
- C. Purify fluid(s)
- D. None of the Above

461. According to the text, the process of reverse osmosis _____ through the membrane, and the most common force is pressure from a pump.

- A. Percentage of permeate
- B. Concentrate
- C. A driving force to push the fluid
- D. None of the Above

462. Which of the following of the fluid being rejected increases, the driving force required to continue concentrating the fluid increases?

- A. The concentration
- B. The higher the pressure
- C. Purify fluid(s)
- D. None of the Above

463. RO is capable of rejecting bacteria, salts, _____, proteins, particles, dyes, and other constituents that have a molecular weight of greater than 150-250 daltons.
- A. Charged Particles
 - B. Concentrate
 - C. Sugars
 - D. None of the Above

464. The separation of ions with reverse osmosis is aided by?
- A. Charged Particles
 - B. Concentrate
 - C. Electricity
 - D. None of the Above

Disinfection Section

Chlorine's Appearance and Odor

465. Prolonged exposures to chlorine gas may result in?
- A. Moisture, steam, and water
 - B. Odor thresholds
 - C. Olfactory fatigue
 - D. None of the Above

466. Chlorine is a greenish-yellow gas it will condense to an amber liquid at approximately _____ F or at high pressures.
- A. -29.2 degrees
 - B. - 100 degrees
 - C. 29 degrees
 - D. None of the Above

Reactivity

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

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

468. 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
- B. Odor thresholds
- C. Moisture, steam, and water
- D. None of the Above

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

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

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

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

471. 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

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

- A. True
- B. False

473. 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

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

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

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

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

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

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

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

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

478. Chlorination is more effective as?

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

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

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

480. Chlorination is less effective in?

- A. Clear water C. Day time
B. Cloudy (turbid) water D. None of the Above

481. 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

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

- A. True B. False

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

- A. True B. False

484. The disassociation of chlorine gas

(OCI -): HOCl H⁺ + OCl⁻ Also expressed HOCl → H⁺ + OCl⁻
(hypochlorous acid) (hydrogen) (hypochlorite ion)

- A. True B. False

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

- A. True B. False

486. 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

487. 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

488. 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

489. 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

490. 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 C. Ammonia residual(s)
B. Chloramines D. None of the Above

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

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

Chlorine Dioxide

492. 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 C. Ammonia residual(s)
B. Chlorine dioxide D. None of the Above

493. 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 (NaClO_2).

- A. Chloramine
- B. Chlorine gas
- C. Chlorine dioxide
- D. None of the Above

494. 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

495. 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

496. 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

Ozone

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

- A. True
- B. False

498. 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

499. 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

500. 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