

**Registration form**

**WWT 303 TRAINING COURSE \$200.00  
48 HOUR RUSH ORDER PROCESSING FEE ADDITIONAL \$50.00**

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

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](mailto:info@tlch2o.com)**

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## **DISCLAIMER NOTICE**

I understand that it is my responsibility to ensure that this CEU course is either approved or accepted in my State for CEU credit. I understand State laws and rules change on a frequent basis and I believe this course is currently accepted in my State for CEU or contact hour credit, if it is not, I will not hold Technical Learning College responsible. I 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.

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*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 303 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*

- |             |             |             |             |
|-------------|-------------|-------------|-------------|
| 1. A B      | 17. A B C D | 33. A B C D | 49. A B C D |
| 2. A B      | 18. A B     | 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 C D | 36. A B C D | 52. A B C D |
| 5. A B      | 21. A B     | 37. A B     | 53. A B C D |
| 6. A B      | 22. A B C D | 38. A B     | 54. A B C D |
| 7. A B      | 23. A B     | 39. A B     | 55. A B C D |
| 8. A B      | 24. A B C D | 40. A B     | 56. A B C D |
| 9. A B      | 25. A B C D | 41. A B     | 57. A B C D |
| 10. A B     | 26. A B C D | 42. A B C D | 58. A B C D |
| 11. A B C D | 27. A B C D | 43. A B C D | 59. A B C D |
| 12. A B C D | 28. A B     | 44. A B     | 60. A B C D |
| 13. A B C D | 29. A B     | 45. A B     | 61. A B C D |
| 14. A B C D | 30. A B     | 46. A B     | 62. A B C D |
| 15. A B C D | 31. A B C D | 47. A B     | 63. A B C D |
| 16. A B C D | 32. A B     | 48. A B C D | 64. A B     |

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|-------------|--------------|--------------|--------------|
| 65. A B C D | 97. A B C D  | 129. A B     | 161. A B C D |
| 66. A B C D | 98. A B C D  | 130. A B     | 162. A B C D |
| 67. A B C D | 99. A B C D  | 131. A B     | 163. A B C D |
| 68. A B C D | 100. A B C D | 132. A B     | 164. A B C D |
| 69. A B C D | 101. A B C D | 133. A B C D | 165. A B C D |
| 70. A B C D | 102. A B C D | 134. A B     | 166. A B C D |
| 71. A B     | 103. A B C D | 135. A B     | 167. A B C D |
| 72. A B     | 104. A B C D | 136. A B C D | 168. A B C D |
| 73. A B C D | 105. A B C D | 137. A B C D | 169. A B C D |
| 74. A B C D | 106. A B C D | 138. A B     | 170. A B C D |
| 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 C D | 174. A B     |
| 79. A B C D | 111. A B     | 143. A B C D | 175. A B C D |
| 80. A B C D | 112. A B     | 144. A B     | 176. A B C D |
| 81. A B     | 113. A B     | 145. A B     | 177. A B C D |
| 82. A B     | 114. A B     | 146. A B     | 178. A B     |
| 83. A B C D | 115. A B     | 147. A B     | 179. A B     |
| 84. A B C D | 116. A B     | 148. A B     | 180. A B     |
| 85. A B C D | 117. A B     | 149. A B     | 181. A B C D |
| 86. A B     | 118. A B     | 150. A B     | 182. A B C D |
| 87. A B C D | 119. A B     | 151. A B     | 183. A B C D |
| 88. A B C D | 120. A B     | 152. A B     | 184. A B C D |
| 89. A B C D | 121. A B     | 153. A B     | 185. A B C D |
| 90. A B C D | 122. A B     | 154. A B     | 186. A B C D |
| 91. A B C D | 123. A B     | 155. A B     | 187. A B C D |
| 92. A B C D | 124. A B     | 156. A B     | 188. A B C D |
| 93. A B C D | 125. A B     | 157. A B     | 189. A B C D |
| 94. A B C D | 126. A B     | 158. A B C D | 190. A B C D |
| 95. A B C D | 127. A B     | 159. A B C D | 191. A B C D |
| 96. A B C D | 128. A B     | 160. A B C D | 192. A B C D |

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|--------------|--------------|--------------|--------------|
| 193. A B C D | 225. A B     | 257. A B C D | 289. A B C D |
| 194. A B C D | 226. A B     | 258. A B C D | 290. A B C D |
| 195. A B C D | 227. A B C D | 259. A B C D | 291. A B C D |
| 196. A B C D | 228. A B     | 260. A B C D | 292. A B C D |
| 197. A B C D | 229. A B     | 261. A B C D | 293. A B C D |
| 198. A B C D | 230. A B     | 262. A B C D | 294. A B C D |
| 199. A B     | 231. A B     | 263. A B     | 295. A B C D |
| 200. A B     | 232. A B     | 264. A B     | 296. A B C D |
| 201. A B C D | 233. A B C D | 265. A B C D | 297. A B C D |
| 202. A B C D | 234. A B C D | 266. A B C D | 298. A B     |
| 203. A B C D | 235. A B C D | 267. A B C D | 299. A B C D |
| 204. A B C D | 236. A B C D | 268. A B C D | 300. A B C D |
| 205. A B C D | 237. A B C D | 269. A B C D | 301. A B C D |
| 206. A B C D | 238. A B C D | 270. A B     | 302. A B C D |
| 207. A B C D | 239. A B C D | 271. A B     | 303. A B C D |
| 208. A B C D | 240. A B     | 272. A B C D | 304. A B C D |
| 209. A B C D | 241. A B C D | 273. A B C D | 305. A B C D |
| 210. A B C D | 242. A B C D | 274. A B C D | 306. A B C D |
| 211. A B C D | 243. A B C D | 275. A B C D | 307. A B C D |
| 212. A B C D | 244. A B C D | 276. A B C D | 308. A B     |
| 213. A B C D | 245. A B C D | 277. A B     | 309. A B C D |
| 214. A B C D | 246. A B C D | 278. A B     | 310. A B     |
| 215. A B     | 247. A B C D | 279. A B     | 311. A B     |
| 216. A B     | 248. A B C D | 280. A B     | 312. A B     |
| 217. A B C D | 249. A B C D | 281. A B C D | 313. A B     |
| 218. A B C D | 250. A B C D | 282. A B C D | 314. A B     |
| 219. A B C D | 251. A B C D | 283. A B C D | 315. A B C D |
| 220. A B C D | 252. A B C D | 284. A B C D | 316. A B C D |
| 221. A B C D | 253. A B C D | 285. A B C D | 317. A B C D |
| 222. A B C D | 254. A B C D | 286. A B     | 318. A B C D |
| 223. A B C D | 255. A B C D | 287. A B     | 319. A B C D |
| 224. A B     | 256. A B C D | 288. A B C D | 320. A B C D |

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| 321. A B C D | 341. A B C D | 361. A B C D | 381. A B C D |
| 322. A B C D | 342. A B C D | 362. A B C D | 382. A B C D |
| 323. A B     | 343. A B C D | 363. A B C D | 383. A B C D |
| 324. A B     | 344. A B     | 364. A B C D | 384. A B C D |
| 325. A B C D | 345. A B     | 365. A B C D | 385. A B C D |
| 326. A B C D | 346. A B     | 366. A B     | 386. A B C D |
| 327. A B C D | 347. A B C D | 367. A B     | 387. A B C D |
| 328. A B C D | 348. A B C D | 368. A B C D | 388. A B C D |
| 329. A B C D | 349. A B C D | 369. A B C D | 389. A B C D |
| 330. A B C D | 350. A B C D | 370. A B C D | 390. A B C D |
| 331. A B C D | 351. A B     | 371. A B C D | 391. A B C D |
| 332. A B C D | 352. A B     | 372. A B C D | 392. A B C D |
| 333. A B C D | 353. A B     | 373. A B C D | 393. A B C D |
| 334. A B     | 354. A B     | 374. A B C D | 394. A B C D |
| 335. A B     | 355. A B     | 375. A B C D | 395. A B C D |
| 336. A B     | 356. A B     | 376. A B     | 396. A B C D |
| 337. A B C D | 357. A B     | 377. A B     | 397. A B C D |
| 338. A B C D | 358. A B C D | 378. A B     | 398. A B C D |
| 339. A B C D | 359. A B C D | 379. A B     | 399. A B C D |
| 340. A B C D | 360. A B C D | 380. A B     | 400. A B C D |

**Write down any trouble questions here.**

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

**WWT 303  
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?

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

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

Any other concerns or comments.

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**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*



## WWT 303 CEU Course Assignment

**The Assignment is available in Word on the Internet for your Convenience, please visit [www.ABCTLC.com](http://www.ABCTLC.com) and download the assignment and 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](mailto: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. Anaerobic- a condition in which "free" or dissolved oxygen is not present in the aquatic environment.  
A. True    B. False
2. Saprophytic bacteria thrive without the presence of oxygen.  
A. True    B. False
3. 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
4. Oxidation is the addition of hydrogen, removal of oxygen or addition of electrons to an element or compound.  
A. True    B. False
5. Aerobic is a condition in which free or dissolved oxygen is present in the aquatic environment.  
A. True    B. False
6. Aerobic Bacteria will live and reproduce only in an environment containing oxygen.  
A. True    B. False
7. When oxygen chemically combined, such as in water molecules can be used for respiration by aerobes  
A. True    B. False
8. Methane Fermenters – bacteria that break down the volatile acids to methane, carbon dioxide and water.  
A. True    B. False

9. Under anaerobic conditions in wastewater, sulfur compounds or elemental sulfur are reduced to H<sub>2</sub>S or sulfide ions.  
A. True    B. False

10. Anaerobic Bacteria that break down complex solids to volatile acids.  
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. 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

13. 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

14. 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

15. One of the measurements used to assess overall wastewater strength, the amount of oxygen organisms needed to break down wastes in wastewater is referred to as?  
A. BOD                      C. COD  
B. MLSS                      D. None of the Above

16. Some organic compounds are more stable than others are and cannot be quickly broken down by organisms; this is true of \_\_\_\_\_ developed for agriculture and industry.  
A. Most inorganic substances                      C. Many synthetic organic compounds  
B. Organic material(s)                                  D. None of the Above

### Oil and Grease

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

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

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

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

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

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

### **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. 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

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

- A. True
- B. False

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. 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

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

## Primary Wastewater Treatment Section

### Conventional A/S Wastewater Treatment Plant Overview

#### Primary Treatment

30. The initial stage in the treatment of domestic wastewater is known as bar screens.  
A. True B. False

31. Coarse solids are removed from the wastewater in the primary stage of treatment. In some treatment plants, \_\_\_\_\_ may be combined into one basic operation.  
A. Primary and secondary stages C. Suspended growth process(es)  
B. Biological processes D. None of the Above

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

33. The secondary stage uses this term to further purify wastewater.  
A. Primary and secondary stages C. Suspended growth process(es)  
B. Biological processes D. None of the Above

#### Preliminary Treatment

34. Which of the following enters from the collection system into the Coarse Screening process?  
A. Raw wastewater C. Dissolved organic and inorganic constituents  
B. Biological processes D. None of the Above

35. 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 C. Primary sludge  
B. Grit and gravel D. None of the Above

36. Large amounts of \_\_\_\_\_ entering a treatment plant can cause serious operating problems, such as excessive wear of pumps and other equipment.  
A. Solid(s) C. Grit and sand  
B. Finer debris D. Dissolved organic and inorganic constituents

37. 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

38. 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

39. 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

### **Primary Sedimentation**

40. 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
41. 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
42. 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 C. Primary sludge  
B. RAS D. Heavy pollutants
43. 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) C. Dissolved organic and inorganic constituents  
B. Suspended solids D. None of the Above

### **Temperature**

44. The best temperatures for wastewater treatment probably range from 77 to 95 degrees Fahrenheit.  
A. True B. False
45. Hot water is a byproduct of many manufacturing processes, is not a pollutant. When discharged in large quantities, it can raise the temperature of receiving streams improving the natural balance of aquatic life.  
A. True B. False

### **pH**

46. The acidity or alkalinity of wastewater affects both treatment and the environment.  
A. True B. False
47. pH indicates increasing acidity while a low pH indicates increasing alkalinity.  
A. True B. False

## Secondary Treatment Section

### Secondary Treatment

48. The Secondary Treatment stage consists of a biological process such as \_\_\_\_\_ and a physical process, Secondary Clarification.

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

49. The Preliminary Treatment stage removes as much \_\_\_\_\_ as possible using physical processes.

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

50. 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

51. Maintaining a population of microorganisms within the oxidation basins that consumes \_\_\_\_\_ and also adhere to the solids themselves.

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

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

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

53. The two most common conventional methods used to achieve secondary treatment are: \_\_\_\_\_ and suspended growth processes.

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

### Raw Water Screening

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

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

55. 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
- B. A quiet zone
- C. Compacted clay bottoms and sides
- D. None of the above

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

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

### **Pond Lining**

57. Ponds may be lined with a synthetic liner or simply have \_\_\_\_\_.
- A. Wind and algae            C. Compacted clay bottoms and sides  
B. Series or in parallel      D. None of the above
58. Many ponds rely on \_\_\_\_\_ to supply oxygen instead of mechanical aeration.
- A. Wind and algae            C. Compacted clay bottoms and sides  
B. Series or in parallel operation   D. None of the above
59. Filamentous bacteria generally do not cause any operational problems in lagoons, in contrast to activated sludge where \_\_\_\_\_ and poor sludge settling is a common problem.
- A. Redox potential            C. BOD removal  
B. Filamentous bulking      D. None of the Above
60. Most heterotrophic bacteria have a wide range in environmental tolerance and can function effectively in \_\_\_\_\_ over a wide range in pH and temperature.
- A. Redox potential            C. BOD removal  
B. Poor sludge settling      D. None of the Above
61. 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            C. 6.5 to 7.0  
B. 6.5 to 9.0            D. None of the Above
62. BOD removal generally declines rapidly below \_\_\_\_\_ C and ceases at \_\_\_\_\_ C.
- A. 3-4° - 1-2°            C. 1-2° - 3-4°  
B. 4-6° - 2-3°            D. None of the Above
63. A very specialized group of bacteria occurs to some extent in lagoons (and other wastewater treatment systems) that can oxidize ammonia via nitrite to nitrate, termed nitrifying bacteria. These bacteria are strict aerobes and require a redox potential of at least +200 m V.
- A. +200    C. 2,000  
B. - 200    D. None of the Above

### **Lagoon Systems**

64. Lagoon systems are shallow basins that hold the wastewater for several months to allow for the natural degradation of sewage.
- A. True    B. False
65. Lagoon systems take advantage of \_\_\_\_\_ and microorganisms in the wastewater to renovate sewage.
- A. Nitrogen removal system(s)            C. Natural aeration  
B. Suspended film system(s)            D. None of the Above

### **Microorganisms in Lagoons**

66. Swimming and \_\_\_\_\_ engulf bacteria or other prey.
- A. Gliding ciliates            C. Heterotrophic bacteria  
B. Predators            D. None of the Above

67. 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

68. Predators feed mostly on stalked and \_\_\_\_\_.

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

69. 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

70. Food (organic loading) regulates \_\_\_\_\_?

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

### Lagoon Microorganisms Introduction

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

- A. True
- B. False

72. Three bacteria groups occur: freely dispersed, single bacteria; floc-forming bacteria; and filamentous bacteria. All function similarly to oxidize organic carbon to produce CO<sub>2</sub> and new bacteria.

- A. True
- B. False

73. 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

74. 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

75. 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

76. 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

77. 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



78. Which of the following bugs or terms occur in lagoons, usually at specific growth environments?  
 A. Anaerobic action                      C. A number of filamentous bacteria  
 B. Absence of free oxygen              D. None of the Above
79. 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                      C. Most heterotrophic bacteria  
 B. Predators                              D. None of the Above
80. 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                      C. Nitrifying bacteria  
 B. Predators                              D. None of the Above

**Mixed or Suspended Lagoons**

81. 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
82. 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
83. In the facultative lagoons, the power input is reduced causing accumulation of solids in the bottom which undergo \_\_\_\_\_, while the upper portions are maintained aerobic.  
 A. Facultative lagoon(s)                      C. Dissolved organic and inorganic constituents  
 B. Anaerobic decomposition                      D. None of the Above

**Advanced Methods of Wastewater Treatment**

84. As our country and the demand for clean water have grown, it has become more important to produce cleaner wastewater effluents, yet \_\_\_\_\_ are more difficult to remove than others.  
 A. Biofilm                                      C. Soluble nutrients  
 B. Some contaminants                      D. None of the Above
85. All WWTPs provide a minimum of?  
 A. Biofilm and chemical removal                      C. Pretreatment and pollution prevention  
 B. Secondary treatment                      D. None of the Above

**Advanced Treatment Technologies**

86. WWTP treatment levels beyond secondary treatment are called advanced treatment.  
 A. True    B. False
87. Which of the following can be extensions of conventional secondary biological treatment to further stabilize oxygen-demanding substances?  
 A. Hydraulic Detention Time                      C. Advanced treatment technologies  
 B. Activated sludge system                      D. None of the Above

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

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

## Activated Sludge Process Section

### Regular MLSS Removal

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

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

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

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

91. Some clarifiers have separate pipelines for RAS and WAS. In other cases, WAS is pumped out of the \_\_\_\_\_ pipeline.

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

### Wasting Rates

92. 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

93. 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

94. CRT was defined as the average length of time in days that an organism remains in the \_\_\_\_\_.

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

95. The operator determines the operating \_\_\_\_\_ for the facility and maintains it through wasting the appropriate amount of excess biomass (Waste Activated Sludge, WAS) from the secondary system.

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

96. The amount of \_\_\_\_\_ in the secondary system is controlled and maintained through solids wasting.

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

97. If intermittent wasting is practiced, it is usually best to waste over as long a time period as practical, and when the loading on the \_\_\_\_\_ is at the low point of the day.

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

98. Drastic changes should not be made in wasting rates from one day to the next; allow the \_\_\_\_\_ time to acclimate to a change before another change is made.

- A. Secondary sludge wasting
- B. Biological system
- C. Advanced system
- D. None of the above

99. Consistency is a key element in successful \_\_\_\_\_ operation.

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

100. Many activated sludge plants were originally designed to waste secondary solids into the primary clarifiers. The reasoning was that as the less dense biological solids co-settle with the \_\_\_\_\_ the combined sludge density would be increased.

- A. Mixed Liquor
- B. Heavier primary solids
- C. Scum
- D. None of the above

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

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

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

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

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

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

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

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

### Environmental Conditions

105. 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

106. 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
- C. BOD, nutrients, and oxygen
- B. WAS
- D. None of the above

### Sludge Settling

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

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

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

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

109. Waste activated sludge also determines the \_\_\_\_\_.

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

### Organic Load

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

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

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

- A. True
- B. False

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

- A. True
- B. False

### Common Types

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

- A. True
- B. False

### Sludge Problems and Solutions Section

#### Excess Solids

114. 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)**

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

A. True B. False

**Clarifier Sludge Blanket**

116. 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

**Clarifier Sludge Blanket**

117. 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**

118. 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**

119. 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**

120. 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**

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

A. True B. False

**Filaments**

122. 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**

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

A. True B. False

**Pin Flocc**

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

A. True B. False

**Sludge Age**

125. 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

126. 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)**

127. 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**

128. 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

**Extended Aeration Activated Sludge Plants**

129. 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

**Denitrification in Final Clarifier**

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

A. True B. False

**Old Sludge**

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

A. True B. False

### Stable Nitrification

132. 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

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

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

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

### Slimy Foam

134. 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

135. 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

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

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

### Denitrification

137. When \_\_\_\_\_ flow rates are too low, thin 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

## Nutrient Section

### TKN

138. The TKN content of influent municipal wastewater is typically between 5,000 and 6,000 mg/L.  
A. True B. False

139. Organic nitrogen compounds in wastewater undergo microbial conversion to  $\text{NH}_3$  and ammonium ion  $\text{NH}_4^+$ .  
A. True B. False

140. 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

141. Inert means the material is safe for all microorganisms.  
A. True B. False

### Ammonia

142. 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

143. Ammonia is a nutrient that contains\_\_\_\_\_. Its chemical formula is  $\text{NH}_3$  in the un-ionized state and  $\text{NH}_4^+$  in the ionized form.  
A. Nitrogen and hydrogen C. Phosphate  
B. Total ammonia D. Both total and unionized ammonia

### Nitrification

144. Nitrification is an anaerobic process in which heterotrophic bacteria oxidize carbon for energy production.  
A. True B. False

145. Nitrification is normally a one-step aerobic biological process for the oxidation of ammonia to nitrate.  
A. True B. False

146. Ammonia-nitrogen ( $\text{NH}_3\text{-N}$ ) is first converted to nitrite ( $\text{NO}_2^-$ ) by ammonia oxidizing bacteria (AOB). The nitrite produced is then converted to nitrate ( $\text{NO}_3^-$ ) 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

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



**Autotrophic Bacteria**

148. AOB and NOB are classified as autotrophic bacteria because they derive energy from the oxidation of reduced inorganic compounds (in this case, nitrogenous compounds) and use inorganic carbon (CO<sub>2</sub>) as a food source.

A. True B. False

**Significant Amount of Oxygen**

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

A. True B. False

**Nitrogen Gas**

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

A. True B. False

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

A. True B. False

**Total Inorganic Nitrogen (TIN)**

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

A. True B. False

**Total Nitrogen**

153. 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

154. 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

**Conversion of Nitrate to Nitrogen Gas**

155. 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

156. 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

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

A. True B. False

### Phosphorus Section

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

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

159. \_\_\_\_\_ is generally precipitated out and removed with the sludge.

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

160. 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

161. 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)

162. 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

163. \_\_\_\_\_ can be hydrolyzed into orthophosphate during the treatment process.

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

### Biological Phosphorus Control

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

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

### Phosphate Accumulating Organisms (PAOs)

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

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

### Production of Polyphosphate

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

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

### Luxury Uptake

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

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

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

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

### Logistical Problem

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

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

### Adenosine Triphosphate (ATP) Energy

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

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

### Chemical Precipitation of Phosphorus

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

- A. True
- B. False

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

- A. True
- B. False

### Tertiary Filtration

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

- A. True
- B. False

## Biological Phosphorus Removal and Combination Processes Principles

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

- A. True    B. False

### Fuhs & Chen Theory

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

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

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

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

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

### Johannesburg (JHB), Modified Johannesburg and Westbank

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

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

### Nitrification and Nutrient Removal Sub-Section

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

- A. True    B. False

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

- A. True    B. False

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

- A. True    B. False

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

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

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

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

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

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

184. Anaerobic methane formation involves \_\_\_\_\_ bacteria.

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

185. 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

186. 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

187. 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

188. 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

189. 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

190. 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

191. 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

192. 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

193. 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

194. 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

195. 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

196. 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

197. 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

198. 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

199. 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**

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

- A. True
- B. False

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

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

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

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

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

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

**The TKN method has three major steps:**

204. 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

205. 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

206. Digestion to convert organic nitrogen to?

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

207. 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

208. 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

209. Nitrogen components in wastewater are typically reported on an "\_\_\_\_\_ " basis?

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

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

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

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

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

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

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

### **Filamentous Bacteria**

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

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

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

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

### **Site Specific Bacteria**

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

- A. True
- B. False

### **Facultative Bacteria**

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

- A. True
- B. False

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

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

### **Anaerobic Bacteria**

218. 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

219. 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

220. A typical use for \_\_\_\_\_ would be in a septic tank.

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

221. 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



### **Aerobic Bacteria**

222. The metabolism of aerobes is much higher than?

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

223. The by-products of \_\_\_\_\_ are carbon dioxide and water.

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

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

- A. True
- B. False

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

- A. True
- B. False

### **Bacteria Section**

226. 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

227. Many bacteria exist as \_\_\_\_\_ and the study of biofilms is very important.

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

### **Peritrichous Bacteria**

228. Pleomorphic bacteria can assume a variety of shapes.

- A. True
- B. False

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

- A. True
- B. False

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

- A. True
- B. False

### **Shigella dysenteriae**

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

- A. True
- B. False

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

- A. True
- B. False

### Salmonella

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

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

### Fecal Coliform Bacteria

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

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

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

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

### Protozoans and Metazoans

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

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

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

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

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

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

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

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

### Dispersed Growth

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

- A. True
- B. False

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

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

**Paramecium sp.**

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

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

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

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

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

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

**Activated Sludge Bugs**

245. The 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

246. 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

247. 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

248. 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

249. 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

250. 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

251. 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

252. 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

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

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

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

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

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

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

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

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

**Vorticella sp.**

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

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

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

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

**Euglypha sp.**

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

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

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

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

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

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

### **Euchlanis sp.**

262. Euchlanis is a typical?

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

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

- A. True
- B. False

### **Activated Sludge Aerobic Flocs**

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

- A. True
- B. False

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

265. Which of the following 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

266. 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

267. 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

### **Filamentous Organisms**

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

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

### **Filamentous Bacteria Identification**

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

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

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

- A. True
- B. False

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

- A. True    B. False

**Microthrix parvicella**

272. Microthrix parvicella is another common cause of?

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

**Sphaeroliticus natans**

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

- A. True    B. False

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

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

**Filamentous Bacteria**

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

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

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

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

**Biological Criteria Sub-Section**

**Water Quality Criteria**

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

- A. True    B. False

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

- A. True    B. False

**Human Health Criteria**

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

- A. True    B. False

### **Aquatic Life Criteria**

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

- A. True    B. False

### **Biological Criteria**

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

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

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

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

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

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

### **Genera**

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

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

## **Laboratory Analysis/ Process Control Section**

### **pH Testing Section**

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

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

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

- A. True    B. False

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

- A. True    B. False

288. Pure water has a pH very close to?

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

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

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

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

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

291. 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

292. 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

293. 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

294. 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

295. 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

296. 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

297. 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

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

- A. True
- B. False



299. 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

300. 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

301. 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

302. 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

303. 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

304. 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

305. 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

306. 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

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

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

### Dissolved Oxygen Testing Section

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

A. True B. False

309. 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

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

A. True B. False

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

A. True B. False

312. The saprophytes exist on dead or decaying materials.

A. True B. False

313. 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

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

A. True B. False

315. Dissolved oxygen level is important because too much or not enough dissolved oxygen can create \_\_\_\_\_?

A. Unfavorable conditions C. Frequent dissolved oxygen measurement  
B. DO analysis D. None of the Above

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

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

317. Which of the following live on the volatile acids produced by these saprophytes?

A. Butyric acid fermenters C. VFAs  
B. Methane fermenters D. None of the Above

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

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

319. \_\_\_\_\_ in a water sample can be detrimental to metal pipes in high concentrations because oxygen helps accelerate corrosion.

A. Carbon dioxide C. Dissolved Oxygen  
B. pH D. None of the Above

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

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

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

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

### Methods of Determination

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

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

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

- A. True
- B. False

### Iodometric Test

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

- A. True
- B. False

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

- A. True
- B. False

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

- A. True
- B. False

### **Total Dissolved Solids**

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

- A. True
- B. False

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

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

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

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

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

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

### **Total Solids**

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

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

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

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

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

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

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

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

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

- A. True
- B. False

### **Total Suspended Solids (TSS)**

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

- A. True
- B. False

346. 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

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

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

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

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

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

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

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

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

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

- A. True
- B. False

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

- A. True
- B. False

### Settleometer Test

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

- A. True
- B. False

354. 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

355. 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

356. 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

357. 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

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

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

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

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

## Disinfection Section

### Chlorine's Appearance and Odor

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

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

361. Prolonged exposures to chlorine gas may result in?

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

### Reactivity

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

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

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

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

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

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

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

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

### Flammability

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

- A. True
- B. False

367. 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

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

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





380. 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

381. 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

382. 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

### **Pretreatment Section**

383. 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

384. 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

385. 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

386. 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

387. Which of the following which result 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

388. Which of the following terms, 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

### **Categorical Standards**

389. 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            C. Discharge of specific pollutants  
B. Pass through                                        D. None of the Above

390. 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**

391. 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

392. 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

393. 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)**

394. 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

395. 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

396. 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

397. 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

**Environmental problem with FOG sewers**

398. 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

399. 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**

400. 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