

**Registration form**

**WWT WATER QUALITY TRAINING COURSE  
48 HOUR RUSH ORDER PROCESSING FEE ADDITIONAL \$50.00**

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

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

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

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

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

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

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

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

**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)**

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

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

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

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

## **DISCLAIMER NOTICE**

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

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

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

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

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

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

## **AFFIDAVIT OF EXAM COMPLETION**

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

## **Grading Information**

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

## CERTIFICATION OF COURSE PROCTOR

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

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

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

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

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

I certify that:

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

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

Notation of any problem or concerns:

Name and Telephone of Proctor (please print):

\_\_\_\_\_  
\_\_\_\_\_

Signature of Proctor



# WWT WATER QUALITY CEU Course Answer Key

Name \_\_\_\_\_

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

Did you check with your State agency to ensure this course is accepted for credit?  
**No refunds.**

**Method of Course acceptance confirmation. Please fill this section**

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

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

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

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

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

- |             |             |             |             |
|-------------|-------------|-------------|-------------|
| 1. A B C D  | 20. A B     | 39. A B     | 58. A B C D |
| 2. A B C D  | 21. A B C D | 40. A B     | 59. A B C D |
| 3. A B C D  | 22. A B     | 41. A B C D | 60. A B C D |
| 4. A B C D  | 23. A B     | 42. A B C D | 61. A B C D |
| 5. A B C D  | 24. A B     | 43. A B C D | 62. A B C D |
| 6. A B C D  | 25. A B     | 44. A B C D | 63. A B C D |
| 7. A B      | 26. A B     | 45. A B C D | 64. A B C D |
| 8. A B C D  | 27. A B C D | 46. A B C D | 65. A B C D |
| 9. A B C D  | 28. A B C D | 47. A B     | 66. A B C D |
| 10. A B C D | 29. A B C D | 48. A B C D | 67. A B C D |
| 11. A B     | 30. A B C D | 49. A B C D | 68. A B C D |
| 12. A B C D | 31. A B C D | 50. A B C D | 69. A B     |
| 13. A B     | 32. A B     | 51. A B C D | 70. A B C D |
| 14. A B C D | 33. A B     | 52. A B C D | 71. A B     |
| 15. A B C D | 34. A B C D | 53. A B C D | 72. A B C D |
| 16. A B C D | 35. A B C D | 54. A B C D | 73. A B C D |
| 17. A B C D | 36. A B C D | 55. A B C D | 74. A B C D |
| 18. A B     | 37. A B C D | 56. A B C D | 75. A B C D |
| 19. A B C D | 38. A B C D | 57. A B C D | 76. A B     |

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|--------------|--------------|--------------|--------------|
| 77. A B C D  | 109. A B C D | 141. A B     | 173. A B C D |
| 78. A B      | 110. A B     | 142. A B C D | 174. A B     |
| 79. A B C D  | 111. A B     | 143. A B     | 175. A B C D |
| 80. A B      | 112. A B C D | 144. A B C D | 176. A B C D |
| 81. A B C D  | 113. A B     | 145. A B     | 177. A B C D |
| 82. A B C D  | 114. A B C D | 146. A B C D | 178. A B C D |
| 83. A B C D  | 115. A B C D | 147. A B     | 179. A B C D |
| 84. A B C D  | 116. A B C D | 148. A B C D | 180. A B C D |
| 85. A B C D  | 117. A B     | 149. A B     | 181. A B     |
| 86. A B      | 118. A B     | 150. A B C D | 182. A B     |
| 87. A B      | 119. A B     | 151. A B C D | 183. A B C D |
| 88. A B C D  | 120. A B     | 152. A B     | 184. A B     |
| 89. A B C D  | 121. A B     | 153. A B     | 185. A B     |
| 90. A B      | 122. A B     | 154. A B C D | 186. A B C D |
| 91. A B C D  | 123. A B C D | 155. A B     | 187. A B C D |
| 92. A B C D  | 124. A B C D | 156. A B C D | 188. A B C D |
| 93. A B      | 125. A B C D | 157. A B     | 189. A B C D |
| 94. A B      | 126. A B C D | 158. A B C D | 190. A B     |
| 95. A B      | 127. A B     | 159. A B C D | 191. A B     |
| 96. A B      | 128. A B C D | 160. A B C D | 192. A B     |
| 97. A B      | 129. A B C D | 161. A B C D | 193. A B     |
| 98. A B C D  | 130. A B     | 162. A B C D | 194. A B     |
| 99. A B C D  | 131. A B C D | 163. A B     | 195. A B     |
| 100. A B     | 132. A B     | 164. A B C D | 196. A B     |
| 101. A B     | 133. A B     | 165. A B     | 197. A B     |
| 102. A B     | 134. A B     | 166. A B C D | 198. A B     |
| 103. A B C D | 135. A B     | 167. A B     | 199. A B     |
| 104. A B C D | 136. A B     | 168. A B     | 200. A B     |
| 105. A B C D | 137. A B C D | 169. A B C D | 201. A B     |
| 106. A B C D | 138. A B C D | 170. A B C D | 202. A B     |
| 107. A B C D | 139. A B C D | 171. A B C D | 203. A B     |
| 108. A B C D | 140. A B C D | 172. A B C D | 204. A B C D |

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|--------------|--------------|--------------|--------------|
| 205. A B     | 237. A B     | 269. A B C D | 301. A B C D |
| 206. A B     | 238. A B     | 270. A B C D | 302. A B     |
| 207. A B C D | 239. A B     | 271. A B C D | 303. A B C D |
| 208. A B     | 240. A B     | 272. A B C D | 304. A B C D |
| 209. A B     | 241. A B     | 273. A B C D | 305. A B C D |
| 210. A B C D | 242. A B     | 274. A B C D | 306. A B C D |
| 211. A B     | 243. A B     | 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 C D |
| 213. A B C D | 245. A B C D | 277. A B C D | 309. A B C D |
| 214. A B     | 246. A B C D | 278. A B C D | 310. A B C D |
| 215. A B C D | 247. A B     | 279. A B C D | 311. A B C D |
| 216. A B C D | 248. A B     | 280. A B     | 312. A B C D |
| 217. A B C D | 249. A B     | 281. A B     | 313. A B C D |
| 218. A B C D | 250. A B     | 282. A B     | 314. A B     |
| 219. A B C D | 251. A B C D | 283. A B     | 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     | 285. A B     | 317. A B C D |
| 222. A B C D | 254. A B     | 286. A B C D | 318. A B C D |
| 223. A B     | 255. A B     | 287. A B     | 319. A B C D |
| 224. A B     | 256. A B     | 288. A B C D | 320. A B C D |
| 225. A B     | 257. A B     | 289. A B C D | 321. A B C D |
| 226. A B     | 258. A B     | 290. A B C D | 322. A B C D |
| 227. A B     | 259. A B     | 291. A B C D | 323. A B C D |
| 228. A B     | 260. A B     | 292. A B     | 324. A B C D |
| 229. A B     | 261. A B     | 293. A B     | 325. A B C D |
| 230. A B     | 262. A B     | 294. A B C D | 326. A B C D |
| 231. A B     | 263. A B     | 295. A B C D | 327. A B C D |
| 232. A B     | 264. A B     | 296. A B C D | 328. A B C D |
| 233. A B     | 265. A B     | 297. A B C D | 329. A B C D |
| 234. A B     | 266. A B     | 298. A B C D | 330. A B C D |
| 235. A B     | 267. A B C D | 299. A B     | 331. A B C D |
| 236. A B     | 268. A B C D | 300. A B C D | 332. A B C D |

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|--------------|--------------|--------------|--------------|
| 333. A B C D | 365. A B C D | 397. A B C D | 429. A B C D |
| 334. A B C D | 366. A B     | 398. A B C D | 430. A B C D |
| 335. A B C D | 367. A B C D | 399. A B C D | 431. A B C D |
| 336. A B C D | 368. A B C D | 400. A B C D | 432. A B C D |
| 337. A B C D | 369. A B C D | 401. A B C D | 433. A B C D |
| 338. A B C D | 370. A B C D | 402. A B C D | 434. A B     |
| 339. A B C D | 371. A B C D | 403. A B C D | 435. A B     |
| 340. A B C D | 372. A B C D | 404. A B C D | 436. A B C D |
| 341. A B C D | 373. A B C D | 405. A B     | 437. A B C D |
| 342. A B C D | 374. A B C D | 406. A B C D | 438. A B     |
| 343. A B C D | 375. A B C D | 407. A B C D | 439. A B     |
| 344. A B C D | 376. A B C D | 408. A B     | 440. A B     |
| 345. A B     | 377. A B C D | 409. A B     | 441. A B C D |
| 346. A B C D | 378. A B C D | 410. A B C D | 442. A B C D |
| 347. A B C D | 379. A B C D | 411. A B C D | 443. A B C D |
| 348. A B C D | 380. A B C D | 412. A B C D | 444. A B C D |
| 349. A B C D | 381. A B C D | 413. A B C D | 445. A B C D |
| 350. A B C D | 382. A B C D | 414. A B C D | 446. A B C D |
| 351. A B C D | 383. A B C D | 415. A B C D | 447. A B C D |
| 352. A B C D | 384. A B C D | 416. A B C D | 448. A B C D |
| 353. A B C D | 385. A B C D | 417. A B C D | 449. A B     |
| 354. A B C D | 386. A B C D | 418. A B     | 450. A B C D |
| 355. A B C D | 387. A B C D | 419. A B C D | 451. A B C D |
| 356. A B C D | 388. A B C D | 420. A B     | 452. A B C D |
| 357. A B C D | 389. A B C D | 421. A B C D | 453. A B C D |
| 358. A B     | 390. A B C D | 422. A B C D | 454. A B C D |
| 359. A B C D | 391. A B C D | 423. A B     | 455. A B     |
| 360. A B C D | 392. A B C D | 424. A B     | 456. A B C D |
| 361. A B C D | 393. A B C D | 425. A B     | 457. A B C D |
| 362. A B C D | 394. A B C D | 426. A B C D | 458. A B C D |
| 363. A B C D | 395. A B C D | 427. A B C D | 459. A B     |
| 364. A B C D | 396. A B C D | 428. A B C D | 460. A B C D |

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|--------------|--------------|--------------|--------------|
| 461. A B     | 471. A B C D | 481. A B C D | 491. A B C D |
| 462. A B C D | 472. A B C D | 482. A B C D | 492. A B     |
| 463. A B C D | 473. A B     | 483. A B C D | 493. A B C D |
| 464. A B C D | 474. A B     | 484. A B C D | 494. A B C D |
| 465. A B C D | 475. A B C D | 485. A B     | 495. A B C D |
| 466. A B C D | 476. A B C D | 486. A B C D | 496. A B C D |
| 467. A B C D | 477. A B C D | 487. A B C D | 497. A B C D |
| 468. A B C D | 478. A B C D | 488. A B C D | 498. A B C D |
| 469. A B     | 479. A B C D | 489. A B C D | 499. A B C D |
| 470. A B C D | 480. A B C D | 490. A B C D | 500. A B C D |

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

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

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**Signature**

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

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

### **REQUIRED DOCUMENTS**

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

### **IPhone Scanning Instructions**

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

### **FAX**

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

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

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

**WWT WATER QUALITY  
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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## WWT WATER QUALITY 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.**

### Hyperlink to the Glossary and Appendix

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

### Biological

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

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

### Organic Matter

2. Large amounts of biodegradable materials can reduce or deplete the \_\_\_\_\_ in the water needed by aquatic life.

- A. Carbon Dioxide
- B. Supply of oxygen
- C. Nutrients
- D. None of the Above

3. 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
- B. MLSS
- C. COD
- D. None of the Above

4. 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
- B. Organic material(s)
- C. Many synthetic organic compounds
- D. None of the Above

5. Which of the following wastewater terms are toxic to humans, fish, and aquatic plants and often are disposed of improperly in drains or carried in stormwater?

- A. Nitrogen and phosphorus
- B. Turbidity
- C. Pesticides and herbicide(s)
- D. None of the Above

6. Two toxic \_\_\_\_\_ like benzene and toluene are found in some solvents, pesticides, and other products.
- A. Nutrients from wastewater
  - B. Inorganic materials
  - C. Organic compounds
  - D. None of the Above

### Oil and Grease

7. Fatty organic materials from animals, vegetables, and petroleum are quickly broken down by bacteria and cannot cause pollution in receiving environments.
- A. True
  - B. False
8. Which of the following wastewater terms also adds to the septic tank scum layer, causing more frequent tank pumping to be required?
- A. Nutrients from wastewater
  - B. Inorganic materials
  - C. Excessive grease
  - D. None of the Above
9. Which of the following wastewater terms used for motors and industry are considered hazardous waste and should be collected and disposed of separately from wastewater?
- A. Nitrogen and phosphorus
  - B. Inorganic substances
  - C. Petroleum-based waste oil(s)
  - D. None of the Above
10. When large amounts of oils and greases are discharged, these increase \_\_\_\_\_ and they may float to the surface and harden, causing aesthetically unpleasing conditions.
- A. BOD
  - B. COD
  - C. Petroleum-based waste oil(s)
  - D. None of the Above

### Inorganics

11. 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

12. Which of the following wastewater terms 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
13. 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
14. 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**

15. Inorganic and Synthetic Organic Chemicals can cause \_\_\_\_\_ problems, and many are not effectively removed by conventional wastewater treatment.
- A. Non-toxic                      C. Excessive growth of aerobic bacteria  
B. Non-potable                    D. Taste and odor

### **Primary Treatment**

16. 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. Tertiary Filtration            C. Suspended growth process(es)  
B. Trickling ditch                D. Primary and secondary stages

### **Preliminary Treatment**

17. 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

### **Primary Sedimentation**

18. 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
19. 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

### **Bacteria Section**

20. 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

21. Many bacteria exist as \_\_\_\_\_ and the study of biofilms is very important.
- A. Filamentous Bacteria            C. Application-specific bacteria  
B. A biofilm                            D. None of the Above

### **Peritrichous Bacteria**

22. Pleomorphic bacteria can assume a variety of shapes.
- A. True    B. False
23. 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

24. 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**

25. 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

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

A. True B. False

### **Hyperlink to the Glossary and Appendix**

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

### **Salmonella**

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

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

### **Fecal Coliform Bacteria**

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

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

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

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

### **Filamentous Bacteria**

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

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

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

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

### Site Specific Bacteria

32. 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

33. 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
34. According to the text, usually, facultative bacteria will be \_\_\_\_\_ unless there is some type of mechanical or biochemical process used to add oxygen to the wastewater.  
A. Anaerobic C. Aerobic  
B. Application-specific bacteria D. None of the Above

### Anaerobic Bacteria

35. A typical use for \_\_\_\_\_ would be in a septic tank.  
A. Aerobic bacteria C. Facultative bacteria  
B. Anaerobic bacteria D. None of the Above
36. Which of the following or bugs release hydrogen sulfide as well as methane gas, both of which can create hazardous conditions?  
A. Aerobic bacteria C. Facultative bacteria  
B. Anaerobic bacteria D. None of the Above
37. Which of the following live and reproduce in the absence of free oxygen?  
A. Aerobic bacteria C. Facultative bacteria  
B. Anaerobic bacteria D. None of the Above
38. In order to remove a given amount of organic material in an anaerobic treatment system, the organic material must be exposed to a \_\_\_\_\_ and/or detained for a much longer period of time.  
A. Anaerobic action C. Significantly higher quantity of bacteria  
B. Absence of free oxygen D. None of the Above

### Aerobic Bacteria

39. Aerobic bacteria live and multiply in the presence of free oxygen.  
A. True B. False
40. Facultative bacteria always achieve an aerobic state when oxygen is present.  
A. True B. False
41. The metabolism of aerobes is much higher than?  
A. Application-specific bacteria C. Aerobic bacteria  
B. Anaerobes D. None of the Above
42. The by-products of \_\_\_\_\_ are carbon dioxide and water.  
A. Anaerobic action C. Aerobic bacteria  
B. Application-specific bacteria D. None of the Above

### Protozoans and Metazoans

43. 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

44. 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

45. 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

46. 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

47. 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

48. 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.

49. 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

50. Which of the following bugs is a medium to large size (100-300  $\mu\text{m}$ ) swimming ciliate, commonly observed in activated sludge, sometimes in abundant numbers?

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

51. 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

52. 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

53. 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

54. 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

55. 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

56. 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

57. 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

58. 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

59. 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

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

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

61. 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

62. 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

63. 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.**

64. 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

65. 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.**

66. 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

67. 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

68. 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.**

69. 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

70. Euchlanis is a typical?  
A. Euglypha                      C. Rotifer(s)  
B. Shelled amoeba(s)      D. None of the Above

### **Activated Sludge Aerobic Flocs**

71. 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:**

72. Which of the following wastewater treatment related terms that which settles too slowly and is not compactable, and caused by the predominance of filamentous organisms?  
A. Settling sludge                      C. Bulking sludge  
B. Organic material                      D. None of the Above
73. 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                      C. Biomass health and effluent quality  
B. High solids                              D. None of the Above
74. Which of the following wastewater treatment related terms occurs when sludge that normally settles rises back to the surface after having settled?  
A. Denitrification                              C. Rising sludge  
B. Bulking sludge                              D. None of the Above

### **Filamentous Organisms**

75. Which of the following wastewater treatment related terms reach too high a concentration, they can extend dramatically from the floc particles?  
A. Filamentous organisms                      C. Organic material  
B. Floc particles                              D. None of the Above

### **Filamentous Bacteria Identification**

76. 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
77. 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                      C. Gram-positive, chemoautotrophic, filamentous  
B. Staining gram-positive                      D. None of the Above
78. 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**

79. Microthrix parvicella is another common cause of?
- A. Disruptive foaming
  - B. Mixotrophic
  - C. Viscous brown color
  - D. None of the Above

### **Sphaeroliticus natans**

80. 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

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

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

### **Filamentous Bacteria**

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

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

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

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

### **Other Wastewater Treatment Components**

#### **Biochemical Oxygen Demand**

84. 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**

85. 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

86. 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

87. 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

### **Advanced Methods of Wastewater Treatment**

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

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

89. All WWTPs provide a minimum of?

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

### **Advanced Treatment Technologies**

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

- A. True
- B. False

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

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

92. 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

### **Settleometer Test**

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

- A. True
- B. False

94. 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

95. 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

96. 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

97. 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

98. 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

99. 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

### **pH**

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

- A. True
- B. False

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

- A. True
- B. False

### **Total Dissolved Solids**

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

- A. True
- B. False

103. Which of the following wastewater terms refer to any minerals, salts, metals, cations or anions dissolved in water?

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

104. Which of the following wastewater terms 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

105. The TDS test does not provide much 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**

106. Which of the following wastewater terms 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

107. Which of the following wastewater terms 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

108. Which of the following wastewater terms 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

109. Which of the following wastewater terms is 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

110. 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)**

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

- A. True
- B. False

112. Which of the following wastewater terms 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

113. 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

114. Which of the following wastewater terms 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

115. Which of the following wastewater terms 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

116. Which of the following wastewater terms can block light from reaching submerged vegetation?

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

117. 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

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

- A. True
- B. False

### **Water Quality Criteria**

119. 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

120. 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**

121. 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**

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

A. True B. False

### **Biological Criteria**

123. 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

124. 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

125. 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**

126. 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. Food-to-microorganism ratio, F/M

### **Aerobic Processes**

127. The most common aerobic processes are: activated sludge systems, lagoons, trickling filters and rotating disk contactors.

A. True B. False

128. Which of the following is used to degrade carbonaceous BOD?

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

129. Which of the following is the amount of food provided to the bacteria in the aeration tank (the food-to-microorganism ratio, F/M)?

- A. Carbonaceous BOD
- B. Attached growth processes
- C. Mean cell residence time (MCRT)
- D. Food-to-microorganism ratio, F/M

### **Dissolved Oxygen**

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

- A. True
- B. False

131. At least two general forms of bacteria act in balance in a wastewater digester: Saprophytic organisms and?

- A. Methane Fermenters
- B. DO fermenters
- C. Butyric acid fermenters
- D. Carbon dioxide fermenters

132. Aerobes decompose inorganics in the water; the result is carbon dioxide and H<sub>2</sub>SO<sub>4</sub>.

- A. True
- B. False

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

- A. True
- B. False

134. The saprophytes exist on dead or decaying materials.

- A. True
- B. False

135. 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

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

- A. True
- B. False

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

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

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

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

139. Which of the following wastewater terms live on the volatile acids produced by these saprophytes?

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

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

### **Sludge Volume Index (SVI)**

141. The higher the (SVI), the better is the settling quality of the aerated mixed liquor, low (SVI) of 50 or less is considered a good settling sludge.

- A. True    B. False

142. Poor settling sludge causes lower solids concentration requiring higher RAS rates to maintain a given \_\_\_\_\_ in the activated sludge basin. Consequently, measuring sludge settleability is fundamental to the operation and control of the biological system.

- A. Solid(s)                      C. WAS  
B. MLSS                      D. Sludge

### **Primary Treatment**

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

- A. True    B. False

144. 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

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

- A. True    B. False

146. 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**

147. 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

148. 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

149. 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

150. 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

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

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

152. 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

153. 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

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

- A. Very fine solids
- B. Wastewater effluent
- C. Primary sludge
- D. None of the Above

155. 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

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

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

### Secondary Treatment

157. 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

158. 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

159. 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

160. 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

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

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

162. 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

### Secondary Clarification Process

163. The SCP provides quiescent (or calm) conditions that allow the larger aggregates of solids and microorganisms to settle out for collection.

- A. True
- B. False

164. In the SCP, the majority of microorganism-rich underflow (or lower layer) is re-circulated to Tanks as Return Sludge to help sustain the microorganism population in the?

- A. Trickling filter(s)
- B. Oxidation Ditches
- C. Recirculating sand filters (RSFs)
- D. None of the Above

### Lagoon Systems

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

- A. True
- B. False

166. Lagoon systems take advantage of \_\_\_\_\_ and microorganisms in the wastewater to renovate sewage.

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

### Temperature

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

- A. True
- B. False

168. 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

### Microorganisms in Lagoons

169. Swimming and \_\_\_\_\_ engulf bacteria or other prey.

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

170. 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

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

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

172. 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

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

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

### **Aerobic Bacteria**

174. 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

175. Which of the following bugs or terms 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

176. Which of the following bugs or terms degrade wastes and grows as single bacteria dispersed in the wastewater?

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

177. Which of the following bugs or terms, grow in a large aggregate due to exocellular polymer production?

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

178. 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

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

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

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

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

181. Anaerobic BOD bacteria are replaced by Mesophilic bacteria at temperatures above 35°C).

A. True B. False

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

A. True B. False

183. 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

### **Aerated lagoons**

184. Two types are the most common: 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

185. 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

186. 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

### **Anaerobic Bacteria**

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

A. Nitrifying bacteria C. Anaerobic, heterotrophic bacteria  
B. Aerobic bacteria D. Mixed slaked ciliates

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

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

189. Which of the following bugs or related terms many genera of anaerobic bacteria hydrolyze proteins, fats, and polysaccharides present in wastewater to amino acids?

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

### **Activated Sludge Process Section**

190. Anaerobic- a condition in which "free" or dissolved oxygen is not present in the aquatic environment.

A. True B. False

191. Saprophytic bacteria thrive without the presence of oxygen.

A. True B. False

192. Anaerobic Bacteria breaks down complex solids to volatile acids.

A. True B. False

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

A. True B. False

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

A. True B. False

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

A. True B. False

196. Methane Fermenters – bacteria that break down the volatile acids to methane, carbon dioxide and water.

A. True B. False

197. 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

198. Oxidation is the addition of hydrogen, removal of oxygen or addition of electrons to an element or compound.

A. True B. False

199. 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

### **Basic System Components of Activated Sludge**

200. In the activated sludge process, the wastewater enters an aerated tank where previously developed biological floc particles are brought into contact with the organic matter of the wastewater.

A. True B. False

201. The organic matter is a carbon and an energy source for the bug's cell growth and is converted into cell tissue. The oxidized endproduct is mainly carbon dioxide, CO<sub>2</sub>.

A. True B. False

202. Mixed liquor is suspended solids and consists mostly of microorganisms, suspended matter, and non-biodegradable suspended matter (MLVSS).

A. True B. False

### **Nitrification**

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

A. True B. False

204. 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

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

A. True B. False

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

A. True B. False

207. 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

### **Activated Sludge Methods**

#### **Organic Load**

208. 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

209. 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

210. 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

#### **Common Types**

211. The most common types of activated sludge are the conventional and the continuous flow settling 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

### Photosynthetic Organisms

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

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

213. 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

214. 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

215. 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

216. Which of the following bugs or related terms in which 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

217. 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

218. 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

219. 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

220. 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

221. 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

222. 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
- C. Acid-forming bacteria
- B. Sulfur bacteria
- D. None of the Above

### **Activated Sludge Process Terms**

#### **Excess Solids**

223. 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)**

224. 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**

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

- A. True
- B. False

#### **Filaments**

226. 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**

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

- A. True
- B. False

#### **Pin Floc**

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

- A. True
- B. False

#### **Sludge Age**

229. 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

230. 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)**

231. 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**

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

A. True      B. False

### **Extended Aeration Activated Sludge Plants**

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

A. True      B. False

### **Clarifier Sludge Blanket**

234. 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**

235. 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**

236. 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**

237. 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**

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

A. True      B. False

### **Denitrification in Final Clarifier**

239. 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

240. 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

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

- A. True      B. False

### Slimy Foam

242. 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

243. 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

244. 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

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

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

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

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

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

### Nutrient Section

#### Total Kjeldahl Nitrogen

247. 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

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

- A. True      B. False

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

- A. True      B. False

250. Organic nitrogen compounds in wastewater undergo microbial conversion to  $\text{NH}_3$  and ammonium ion  $\text{NH}_4^+$ .

- A. True      B. False

### **Ammonia**

251. 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

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

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

### **Nitrification**

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

- A. True      B. False

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

- A. True      B. False

255. 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**

256. 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**

257. 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 ( $\text{CO}_2$ ) as a food source.

- A. True      B. False

### **Significant Amount of Oxygen**

258. 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**

259. 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

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

- A. True      B. False

### **Total Inorganic Nitrogen (TIN)**

261. 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**

262. 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

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

- A. True      B. False

### **Conversion of Nitrate to Nitrogen Gas**

264. 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

265. 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

266. 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**

267. 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                      C. 100 to 500  
B. 2 and 4                      D. 1,000 – 2,000

268. 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    C. Phosphoric acid, phosphate ion  
B. Phosphorus        D. Total phosphorus (TP)

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

270. \_\_\_\_\_ can either be in the form of soluble colloids or particulate. It can also be divided into biodegradable and non-biodegradable fractions.  
A. Organically bound phosphorus    C. Soluble biodegradable phosphorus  
B. Phosphorus                            D. Particulate organically bound phosphorus

271. \_\_\_\_\_ is generally precipitated out and removed with the sludge.  
A. Organically bound phosphorus    C. Soluble biodegradable phosphorus  
B. Phosphorus                            D. Particulate organically bound phosphorus

272. \_\_\_\_\_ can be hydrolyzed into orthophosphate during the treatment process.  
A. Polyphosphate                        C. Particulate organically bound phosphorus  
B. Phosphorus                            D. Soluble organically bound non-biodegradable phosphorus

### Biological Phosphorus Control

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

### Phosphate Accumulating Organisms (PAOs)

274. PAOs accomplish removal of phosphate by accumulating it within their cells as \_\_\_\_\_.  
A. Polyphosphate                        C. Both nitrogen and phosphorus  
B. Phosphorus                            D. Soluble organically bound non-biodegradable phosphorus

### Production of Polyphosphate

275. 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                        C. Phosphoric acid, phosphate ion  
B. Phosphorus                            D. Total phosphorus (TP)

### Luxury Uptake

276. 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

277. 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

278. 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

279. 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

280. 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

281. 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

282. 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

283. 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**

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

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

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

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

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

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

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

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

### **Iodometric Test**

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

- A. True
- B. False

288. 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

289. Which of the following wastewater terms 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

290. Which of the following wastewater terms 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

291. Which of the following wastewater terms 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

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

- A. True
- B. False

293. 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

294. Which of the following wastewater terms passes through the membrane and measured by the meter?

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

295. According to the text, 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

296. 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

297. Which of the following wastewater terms –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

298. Which of the following wastewater terms measurement is essential for adequate process control?

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

### **Sludge Volume Index (SVI)**

299. The higher the (SVI), the better is the settling quality of the aerated mixed liquor, low (SVI) of 50 or less is considered a good settling sludge.

- A. True
- B. False

300. The Sludge Volume Index (SVI) of activated sludge is defined as the volume in milliliters occupied by \_\_\_\_\_ after settling for 30 minutes.

- A. 1g of activated sludge
- B. 5g of activated sludge
- C. 10 g of activated sludge
- D. None of the Above

### **Nutrient Constituents in Wastewater and Measurement Methods**

#### **Nitrogen**

301. 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

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

- A. True
- B. False

303. Which of the following in domestic wastewater typically ranges from 20 to 70 mg/L for low to high strength wastewater?  
A. Organic carbon                      C. BOD  
B. Total nitrogen                      D. None of the Above

304. Influent concentration varies during the day and can vary significantly during rainfall events, as a result of?  
A. Oxygen-demanding pollutants                      C. Inflow and infiltration to the collection system  
B. Dissolved oxygen decrease                      D. None of the Above

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

305. Digestion to convert organic nitrogen to?  
A. Ammonium sulfate                      C. Dissolved, biodegradable compounds  
B. Organic nitrogen                      D. None of the Above

306. Conversion of which term into condensed ammonia gas through addition of a strong base and boiling?  
A. Ammonia gas                      C. Ammonia-nitrogen concentration  
B. Ammonium sulfate                      D. None of the Above

307. Measuring the concentration includes ammonia, with this term being subtracted from the TKN to determine organic nitrogen.  
A. Ammonia gas                      C. Ammonia-nitrogen concentration  
B. Ammonium sulfate                      D. None of the Above

308. Nitrogen components in wastewater are typically reported on an " \_\_\_\_\_ " basis?  
A. As Nitrite                      C. As nitrogen  
B. As Nitrate                      D. None of the Above

309. 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                      C. Aliphatic N compounds  
B. Inorganic nitrogen                      D. None of the Above

310. 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                      C. Aliphatic N compounds  
B. Nitrites                      D. None of the Above

311. Which of the following may be released in secondary treatment by microorganisms either through metabolism or upon death and lysis?  
A. TKN                      C. Aliphatic N compounds  
B. Organic nitrogen                      D. None of the Above

312. Which of the following happens by microorganisms releasing organic nitrogen as dissolved, biodegradable compounds?  
A. Ammonia gas                      C. Hydrolysis of particulate and colloidal material  
B. THMs                      D. None of the Above



### Membrane Filtration Processes

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

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

### Description of Membrane Filtration Processes

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

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

### Microfiltration

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

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

325. RO membranes are susceptible to clogging or filter binding unless the \_\_\_\_\_ being processed is already quite clean.

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

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

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

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

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

### Ultrafiltration

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

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

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

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

330. UF does not generally work well for removal of \_\_\_\_\_, it can be used effectively for removal or most organic chemicals.

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

### **Nanofiltration**

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

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

332. NF capability will undoubtedly increase the use of \_\_\_\_\_ for potable water treatment.

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

### **Reverse Osmosis**

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

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

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

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

### **Microfiltration Specific Process**

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

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

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

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

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

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

### **Common Applications**

#### **Water Treatment Process**

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

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

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

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

#### **Driving Force, Retentate Stream and Permeate Streams**

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

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

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

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

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

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

### **Fouling**

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

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

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

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

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

- A. True
- B. False

### **Nanofiltration (NF) Section**

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

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

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

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

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

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

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

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

350. Which of the following are controlled by pH, temperature and time during development with pore densities ranging from 1 to 106 pores per cm<sup>2</sup>?

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

351. Membranes made from polyethylene terephthalate are referred to as \_\_\_\_\_, named after the way the pores on the membranes are made.

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

352. "Tracking" results in making tracks that are chemically developed into the membrane or \_\_\_\_\_ into the membrane, which are the pores.

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

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

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

### Range of Applications

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

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

355. Which of the following can "soften" water by retaining scale-forming, hydrated divalent ions (e.g. Ca<sup>2+</sup>, Mg<sup>2+</sup>) while passing smaller hydrated monovalent ions?

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

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

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

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

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

### Advantages and Disadvantages

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

- A. True
- B. False

359. Which of the following do not operate at room temperature (e.g. distillation), which greatly increases the cost of the process when continuous heating or cooling is applied?
- A. Many separation processes      C. Organic solvent nanofiltration technology  
 B. Gentle molecular separation      D. None of the Above
360. Which of the following is linked with nanofiltration that is often not included with other forms of separation processes (centrifugation)?
- A. Many separation processes      C. Organic solvent nanofiltration technology  
 B. Gentle molecular separation      D. None of the Above
361. Which of the following has a very favorable benefit of being able to process large volumes and continuously produce streams?
- A. Ultrafiltration      C. Nanofiltration  
 B. Microfiltration or MF      D. None of the Above
362. Anything smaller, reverse osmosis is used and anything larger is used for?
- A. Ultrafiltration      C. Nanofiltration  
 B. Microfiltration or MF      D. None of the Above
363. Which of the following can also be used in cases where nanofiltration can be used, due to it being more conventional?
- A. Ultrafiltration      C. Nanofiltration  
 B. Microfiltration or MF      D. None of the Above
364. Which of the following membranes are an expensive part of the process. Repairs and replacement of membranes is dependent on total dissolved solids, flow rate and components of the feed?
- A. Ultrafiltration      C. Nanofiltration  
 B. Microfiltration or MF      D. None of the Above
365. Which of the following being used across various industries, only an estimation of replacement frequency can be used?
- A. Ultrafiltration      C. Nanofiltration  
 B. Microfiltration or MF      D. None of the Above

**Reverse Osmosis Process Section**

366. Osmosis is a natural phenomenon in which a liquid - water in this case - passes through a semi-permeable membrane from a relatively dilute solution toward a more concentrated solution. This flow produces a measurable pressure, called osmotic pressure.
- A. True      B. False
367. Which of the following produces high quality water at low cost compared to other purifications processes?
- A. Ultrafiltration      C. RO  
 B. Microfiltration or MF      D. None of the Above
368. Which of the following is determined by the total dissolved solids content of the saline solution, or contaminated solution on one side of the membrane?
- A. This pressure differential      C. Virtually 100% of colloidal and suspended matter  
 B. Osmotic pressure      D. None of the Above

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

### Brine Channel

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

379. The inverse occurs with lower temperatures, in that salt passage decreases (reducing the \_\_\_\_\_ in the permeate or product water), while operating pressures increase. Or, if operating pressures do not increase, then the amount of permeate or product water is reduced.
- A. TDS  
B. Raw water  
C. Concentrate  
D. None of the Above
380. The rejection rate is the percentage of \_\_\_\_\_ rejected, or prevented from passing through the membrane.
- A. Percentage of permeate  
B. Raw water  
C. Dissolved solids  
D. None of the Above
381. A membrane with a rejection rate of 99% (usually based on Na (Sodium)) will allow only 1% of the concentration of \_\_\_\_\_ to pass through into the permeate.
- A. Percentage of permeate  
B. Raw water  
C. Dissolved solids  
D. None of the Above
382. As the raw water is processed, the concentrations of \_\_\_\_\_ increase as it passes along the membrane's length and usually multiple membranes are employed, with each membrane in series seeing progressively higher dissolved solids levels.
- A. Percentage of permeate  
B. Raw water  
C. TDS  
D. None of the Above
383. Typically, starting with seawater of 36,000 PPM, standard rejection membranes produce?
- A. Permeate above 500 PPM  
B. Permeate below 500 PPM  
C. Amount of permeate or product water  
D. None of the Above
384. Optimum flows and pressures, optimum recovery rates (the \_\_\_\_\_ from a given stream of raw water), prefiltration and other pretreatment considerations, and so forth.
- A. Percentage of permeate  
B. Multi-media filtration  
C. Amount of permeate or product water  
D. None of the Above
385. Well-designed systems employ multiple stages of prefiltration, tailored to the application, including \_\_\_\_\_ and one or more stages of cartridge filtration.
- A. Percentage of permeate  
B. Multi-media filtration  
C. Amount of permeate or product water  
D. None of the Above
386. Which of the following has proved to be the most reliable and cost effective method of desalinating water, and hence its use has become more and more widespread?
- A. Reverse Osmosis  
B. Potable water treatment  
C. Direct filtration process  
D. None of the Above
387. Which of the following is usually some 70% less than for comparable evaporation technologies?
- A. Energy consumption  
B. Component parts  
C. Direct filtration process  
D. None of the Above
388. Which of the following have been improved as well, reducing maintenance and down time?
- A. Each sheet of membrane material  
B. Microporous support layer  
C. Component parts  
D. None of the Above

389. Which of the following delivers product water or permeate having essentially the same temperature as the raw water source?  
 A. Reverse Osmosis                      C. Direct filtration process  
 B. Potable water treatment    D. None of the Above
390. R/O Systems can be designed to deliver virtually any?  
 A. Required product water quality    C. Amount of permeate or product water  
 B. Microporous support layer            D. None of the Above
391. Reverse osmosis, also known as?  
 A. Hyperfiltration                              C. Direct filtration process  
 B. Microfiltration or MF                      D. None of the Above
392. Reverse osmosis is used to purify water and remove salts and other impurities in order to improve the color, taste, or properties of the?  
 A. Cross-flow                      C. Fluid  
 B. Concentrate                      D. None of the Above
393. RO can be used to purify fluids such as ethanol and glycol, which will pass through the reverse osmosis membrane, while rejecting?  
 A. Percentage of permeate                      C. Ions and contaminants  
 B. Raw water                                      D. None of the Above
394. RO is used to produce \_\_\_\_\_ that are currently in place.  
 A. Permeate                      C. Water that meets the most demanding specifications  
 B. Concentrate                      D. None of the Above
395. Reverse osmosis technology uses a process known as \_\_\_\_\_ to allow the membrane to continually clean itself.  
 A. Cross-flow                      C. Fluid  
 B. Concentrate                      D. None of the Above
396. Which of the following passes through the membrane the rest continues downstream, sweeping the rejected species away from the membrane?  
 A. Some of the fluid                      C. Purify fluid(s)  
 B. The higher the pressure    D. None of the Above
397. According to the text, the process of reverse osmosis \_\_\_\_\_ through the membrane, and the most common force is pressure from a pump.  
 A. Percentage of permeate                      C. A driving force to push the fluid  
 B. Concentrate                                      D. None of the Above
398. Which of the following of the fluid being rejected increases, the driving force required to continue concentrating the fluid increases?  
 A. The concentration                      C. Purify fluid(s)  
 B. The higher the pressure    D. None of the Above
399. RO is capable of rejecting bacteria, salts, \_\_\_\_\_, proteins, particles, dyes, and other constituents that have a molecular weight of greater than 150-250 daltons.  
 A. Charged Particles                      C. Sugars  
 B. Concentrate                                      D. None of the Above

400. The separation of ions with reverse osmosis is aided by?

- A. Charged Particles
- B. Concentrate
- C. Electricity
- D. None of the Above

### Chlorine Section

#### Chlorine's Appearance and Odor

401. 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

402. 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

403. 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

404. 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

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

- A. True
- B. False

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

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

407. 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

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

- A. True
- B. False

409. 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

410. The effectiveness of chlorination depends on the \_\_\_\_\_ of the water, the concentration of the chlorine solution added, the time that chlorine is in contact with the organism, and water quality.
- A. Chlorine residual                      C. Oxygen  
B. Chlorine demand                      D. None of the Above
411. Chlorine may not be available for disinfection because \_\_\_\_\_ in the water (like iron, manganese, hydrogen sulfide, and ammonia).
- A. pH increases                              C. Required contact time  
B. Part of it combines with other chemicals      D. None of the Above
412. The amount of chlorine required to achieve disinfection and that reacts with the other chemicals is the?
- A. Chlorine residual                      C. Free chlorine residual  
B. Chlorine demand                      D. None of the Above
413. Which term is used when disinfection decreases, as the concentration of the chlorine increases?
- A. pH increases                              C. Required contact time  
B. Chlorine level and water quality      D. None of the Above
414. Chlorination is more effective as?
- A. Water temperature increases      C. Water cools down  
B. Chlorine demand                      D. None of the Above
415. Chlorination becomes more alkaline and is less effective as the?
- A. Water's pH increases                      C. Required contact time is maximized  
B. Water quality increases                  D. None of the Above
416. Chlorination is less effective in?
- A. Clear water                              C. Day time  
B. Cloudy (turbid) water                  D. None of the Above
417. By adding a little more chlorine to what is already sufficient, this action will generally result in \_\_\_\_\_ that can be measured easily.
- A. pH increases                              C. Required contact time  
B. A free chlorine residual                  D. None of the Above

### **Chlorination Chemistry**

418. The hypochlorite ion is a much weaker disinfecting agent than Hypochlorous acid, about 100 times less effective.
- A. True    B. False
419. 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

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

A. True B. False

421. 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

422. If all other things were equal, \_\_\_\_\_ and a lower pH are more conducive to chlorine disinfection.

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

423. The disassociation of chlorine gas  
(OCI<sup>-</sup>): HOCl H<sup>+</sup> + OCI<sup>-</sup> Also expressed HOCl → H<sup>+</sup> + OCI<sup>-</sup>  
(hypochlorous acid) (hydrogen) (hypochlorite ion)

A. True B. False

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

A. True B. False

425. 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

### Introduction to Chlorine (DDBP)

426. These term means that chlorine is present as Cl<sub>2</sub>, HOCl, and OCI<sup>-</sup> is called \_\_\_\_\_, and that which is bound but still effective is \_\_\_\_\_.

A. Free available chlorine and Total C. Free available chlorine and Combined Chlorine  
B. Free and Residual D. None of the Above

427. Chloramines are formed by reactions with?

A. Acid and Cl<sub>2</sub> C. Folic Acid and Cl<sub>2</sub>  
B. Ammonia and Cl<sub>2</sub> D. None of the Above

### Alternate Disinfectants - Chloramine

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

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

429. In the production of \_\_\_\_\_, the ammonia residuals in the finished water, when fed in excess of stoichiometric amount needed, should be limited to inhibit growth of nitrifying bacteria.

A. Dry sodium chlorite C. Ammonia residual(s)  
B. Chloramines D. None of the Above

### Chlorine Dioxide

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

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

431. If chlorine dioxide is being used as an oxidant, the preferred method of generation is to entrain this term or substance into a packed reaction chamber with a 25% aqueous solution of sodium chlorite (NaClO<sub>2</sub>).

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

432. According to the text, which chemical is explosive and can cause fires in feed equipment if leaking solutions or spills are allowed to dry out?

- A. Dry sodium chlorite
- B. Chlorine dioxide
- C. Ammonia
- D. None of the Above

433. Chlorine dioxide may be used for either taste or odor control or as a?

- A. Chloramine
- B. Pre-disinfectant
- C. Gas
- D. None of the Above

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

- A. True
- B. False

### Ozone

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

- A. True
- B. False

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

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

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

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

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

- A. True
- B. False

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

- A. True
- B. False

**Pretreatment Topic - Prohibited Discharge Standards (Credit USEPA)**

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

A. True B. False

441. Discharges containing pollutants causing corrosive structural damage to the POTW are prohibited, 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

442. 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

443. 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

444. 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

445. Which of the following can result in the presence of toxic gases, vapors, or fumes within the POTW 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

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

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

**Categorical Standards**

447. 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

448. 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 C. Categorical pretreatment standards  
B. Pass through D. None of the Above

449. Effluent limitations guidelines developed in conjunction with categorical standards, limit the discharge from facilities directly to waters of the U.S. and do not apply to indirect dischargers.  
A. True B. False

### **FOG Introduction**

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

450. 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 C. Residential customers  
B. POTWs D. None of the Above

451. 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 C. Least management practices (LMPs)  
B. POTW's requirement(s) D. None of the Above

452. Ponds, streams or rivers will be contaminated due to \_\_\_\_\_ and will also impact the environment negatively.

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

#### **Food Service Establishments (FSEs)**

453. Because of the amount of grease used in cooking, \_\_\_\_\_are a significant source of fats, oil and grease (FOG).

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

454. 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 C. POTW Commercial FOG Program  
B. POTWs D. None of the Above

455. Through implementation of Best Management Practices (BMPs), these establishments should be able to significantly reduce the amount of FOG that goes down their drains. This will minimize back-ups and help business owners comply with the POTW's requirements.

- A. True B. False

456. According to the text, 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 C. Most management practices (MMPs)  
B. POTW's requirement(s) D. None of the Above

457. Various businesses and individuals 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**

458. 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

459. The various sizes of grease balls can range in size from cantaloupes to the size of marble and must be removed periodically.

- A. True
- B. False

460. The repair or replacement of their damaged property caused by FOG creating \_\_\_\_\_ can also cost customers thousands of dollars for the repair or replacement of their damaged property.

- A. Infiltration
- B. Sewer backup(s)
- C. Jump joints
- D. None of the Above

#### **Controlling FOG discharges**

461. FOG wastes are generated at FSEs as byproducts from food preparation activities. FOG captured on-site is generally classified into two broad categories: yellow grease and grease trap waste.

- A. True
- B. False

462. Food service establishment(s) or FSE can adopt a variety of best management practices or install interceptor/collector devices to control and capture the \_\_\_\_\_ before discharge to the POTW collection system.

- A. BMPs
- B. FOG material
- C. Interceptor/collector device(s)
- D. None of the Above

463. 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

#### **Keeping Fats, Oils, and Grease out of the Sewer System**

464. Manholes can overflow into parks, yards, streets, and storm drains, allowing FOG to contaminate local waters, including drinking water. Exposure to untreated wastewater is a public-health hazard and is an EPA violation. FOG discharged into septic systems and drain fields can cause malfunctions, resulting in more frequent tank pump-outs and other expenses.

- A. True
- B. False

465. Which of the following will back up into homes and businesses, resulting in high costs for cleanup and restoration?

- A. Dye
- B. Untreated wastewater.
- C. Your negligence
- D. None of the Above

**POTWs control methods for FOG discharges from FSEs**

466. There are many different devices, methods and procedures i.e., Proper design, installation, and maintenance procedures are critical for these devices to?

- A. Control and capture the Yard waste
- B. Control and capture the FOG
- C. Your negligence
- D. None of the Above

467. FOG must be able to cool and separate in a non-turbulent environment, therefore. \_\_\_\_\_ must be designed and sized appropriately.

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

468. Grease interceptor/ collector devices shall be serviced at regular intervals and \_\_\_\_\_ must be diligent in providing proper maintenance and records.

- A. BMPs
- B. FSE
- C. Honey Pumpers
- D. None of the Above

**Best Management Practices (BMPs)**

469. The amount of FOG a facility generates as well as any best management practices (BMPs) that the establishment implements to reduce the FOG discharged into its sanitary sewer system.

- A. True
- B. False

470. Because of required grease interceptor and trap maintenance frequency, an establishment that implements BMPs will realize a \_\_\_\_\_ benefit.

- A. Financial
- B. Grease interceptor and trap
- C. FOG
- D. None of the Above

**Residential and Commercial Guidelines**

471. 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

**Return back to the Laboratory Section**

**pH Testing Section**

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

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

473. 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

474. 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

475. Pure water has a pH very close to?

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

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

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

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

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

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

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

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

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

480. 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                      C. pH measurement(s)  
B. Alkalinity                      D. None of the Above

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

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

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

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

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

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

484. 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

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

- A. True
- B. False

486. 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

487. Under normal circumstances this means that the concentration of hydrogen ions in acidic solution can be taken to be equal to the concentration of the acid. The pH is then equal to minus the logarithm of?

- A. The concentration value
- B. The pH
- C. A set of non-linear simultaneous equations
- D. None of the Above

488. Alkalinity of water is its acid-neutralizing capacity. It is the sum of all the titratable bases. The measured value may vary significantly with the?

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

489. For strong acids and bases no calculations are necessary except in extreme situations. The pH of a solution containing a weak acid requires the solution of a quadratic equation. The pH of a solution containing a weak base may require the?

- A. Solution of a cubic equation
- B. Non-linear simultaneous equations
- C. Excess of alkaline earth metal concentrations
- D. None of the Above

490. Alkalinity is a measure of this missing term and can be interpreted in terms of specific substances only when the chemical composition of the sample is known.

- A. Universal indicator
- B. An aggregate property of water
- C. Excess of alkaline earth metal concentrations
- D. None of the Above

491. More precise measurements are possible if the color is measured spectrophotometrically, using a?

- A. Universal indicator
- B. Colorimeter or spectrophotometer
- C. Set of non-linear simultaneous equations
- D. None of the Above

492. Because the alkalinity of many surface waters is primarily a function of carbonate, bicarbonate, and hydroxide content, it is taken as an indication of the concentration of these constituents.

- A. True
- B. False

