

**Registration form**

**Wastewater Treatment Bugs 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.

No Refunds.

## 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



# Wastewater Treatment Bugs 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. No Refunds.**

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

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

- |              |              |              |              |
|--------------|--------------|--------------|--------------|
| 73. A B C D  | 105. A B C D | 137. A B C D | 169. A B C D |
| 74. A B C D  | 106. A B C D | 138. A B C D | 170. A B C D |
| 75. A B      | 107. A B     | 139. A B C D | 171. A B C D |
| 76. A B C D  | 108. A B     | 140. A B C D | 172. A B C D |
| 77. A B C D  | 109. A B C D | 141. A B     | 173. A B C D |
| 78. A B C D  | 110. A B C D | 142. A B C D | 174. A B     |
| 79. A B C D  | 111. A B C D | 143. A B     | 175. A B C D |
| 80. A B C D  | 112. A B     | 144. A B C D | 176. A B C D |
| 81. A B      | 113. A B     | 145. A B     | 177. A B C D |
| 82. A B      | 114. A B     | 146. A B C D | 178. A B C D |
| 83. A B C D  | 115. A B     | 147. A B     | 179. A B C D |
| 84. A B C D  | 116. A B     | 148. A B C D | 180. A B C D |
| 85. A B      | 117. A B C D | 149. A B     | 181. A B     |
| 86. A B      | 118. A B C D | 150. A B C D | 182. A B C D |
| 87. A B C D  | 119. A B C D | 151. A B C D | 183. A B C D |
| 88. A B      | 120. A B C D | 152. A B     | 184. A B     |
| 89. A B C D  | 121. A B     | 153. A B     | 185. A B     |
| 90. A B C D  | 122. A B C D | 154. A B C D | 186. A B C D |
| 91. A B      | 123. A B C D | 155. A B     | 187. A B C D |
| 92. A B      | 124. A B     | 156. A B C D | 188. A B C D |
| 93. A B C D  | 125. A B C D | 157. A B     | 189. A B C D |
| 94. A B C D  | 126. A B C D | 158. A B C D | 190. A B     |
| 95. A B C D  | 127. A B     | 159. A B C D | 191. A B     |
| 96. A B C D  | 128. A B C D | 160. A B C D | 192. A B     |
| 97. A B C D  | 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 C D | 134. A B     | 166. A B C D | 198. A B     |
| 103. A B     | 135. A B     | 167. A B     | 199. A B     |
| 104. A B C D | 136. A B     | 168. A B     | 200. A B     |

- |              |              |              |              |
|--------------|--------------|--------------|--------------|
| 201. A B     | 226. A B     | 251. A B C D | 276. A B C D |
| 202. A B     | 227. A B     | 252. A B C D | 277. A B C D |
| 203. A B     | 228. A B     | 253. A B     | 278. A B C D |
| 204. A B C D | 229. A B     | 254. A B     | 279. A B C D |
| 205. A B     | 230. A B     | 255. A B     | 280. A B     |
| 206. A B     | 231. A B     | 256. A B     | 281. A B     |
| 207. A B C D | 232. A B     | 257. A B     | 282. A B     |
| 208. A B     | 233. A B     | 258. A B     | 283. A B     |
| 209. A B     | 234. A B     | 259. A B     | 284. A B     |
| 210. A B C D | 235. A B     | 260. A B     | 285. A B     |
| 211. A B     | 236. A B     | 261. A B     | 286. A B     |
| 212. A B C D | 237. A B     | 262. A B     | 287. A B     |
| 213. A B C D | 238. A B     | 263. A B     | 288. A B C D |
| 214. A B     | 239. A B     | 264. A B     | 289. A B C D |
| 215. A B C D | 240. A B     | 265. A B     | 290. A B C D |
| 216. A B C D | 241. A B     | 266. A B     | 291. A B C D |
| 217. A B C D | 242. A B     | 267. A B C D | 292. A B C D |
| 218. A B C D | 243. A B     | 268. A B C D | 293. A B C D |
| 219. A B C D | 244. A B C D | 269. A B C D | 294. A B C D |
| 220. A B C D | 245. A B C D | 270. A B C D | 295. A B C D |
| 221. A B C D | 246. A B C D | 271. A B C D | 296. A B     |
| 222. A B C D | 247. A B     | 272. A B C D | 297. A B     |
| 223. A B     | 248. A B     | 273. A B C D | 298. A B     |
| 224. A B     | 249. A B     | 274. A B C D | 299. A B     |
| 225. A B     | 250. A B     | 275. A B C D | 300. A B     |

**Please write down any issues with questions.**

*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.**

---

**Signature**

## **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 not be in non-compliance and do not follow this course for proper compliance.*

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

**WASTEWATER TREATMENT BUGS  
CEU TRAINING COURSE  
CUSTOMER SERVICE RESPONSE CARD**

NAME: \_\_\_\_\_

E-MAIL \_\_\_\_\_ PHONE \_\_\_\_\_

***PLEASE COMPLETE THIS FORM BY CIRCLING THE NUMBER OF THE APPROPRIATE ANSWER IN THE AREA BELOW.***

Please rate the difficulty of your course.

Very Easy 0 1 2 3 4 5 Very Difficult

Please rate the difficulty of the testing process.

Very Easy 0 1 2 3 4 5 Very Difficult

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

Very Similar 0 1 2 3 4 5 Very Different

How did you hear about this Course? \_\_\_\_\_

What would you do to improve the Course?

---

---

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

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

Any other concerns or comments.

---

---

---



# Wastewater Treatment Bugs

## 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 e mail 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>

### Bacteria Section

1. 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

2. Some bacteria are basically rods but instead of being straight they are often twisted, bent or curved, sometimes in a spiral.

A. True B. False

3. When bacteria live in chains, one after the other, they are called \_\_\_\_\_ - these often have long thin cells.

A. Biofilm bacteria C. A biofilm  
B. Filamentous bacteria D. None of the Above

4. 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

5. Pleomorphic bacteria can assume a variety of shapes.

A. True B. False

6. 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

7. 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**

8. *Shigella dysenteriae* is a species of the rod-shaped bacterial genus *Shigella* (bacillary dysentery).  
A. True B. False
9. Enterotoxin and Shiga toxin can cause shigellosis (bacillary dysentery).  
A. True B. False
10. Shigellae are Gram-negative, non-spore-forming, facultatively anaerobic, Pleomorphic bacteria.  
A. True B. False
11. *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
12. Amebiasis is typically via ingestion (fecal-oral contamination); depending on age and condition of the host, as few as ten bacterial cells can be enough to cause an infection.  
A. True B. False
13. *Shigella* causes dysentery that result in the destruction of the epithelial cells of the intestinal mucosa in the cecum and rectum.  
A. True B. False
14. Shiga toxin and verotoxin are associated with causing \_\_\_\_\_  
A. Shigellae C. Hemolytic uremic syndrome  
B. Gram-negative bacterium D. None of the Above

### **Salmonella**

15. *Salmonella* is a \_\_\_\_\_.  
A. Gram-negative bacterium C. Fecal coliform bacteria  
B. Fecal coliform bacteria D. None of the Above
16. Because *Salmonella* cause \_\_\_\_\_ and are greatly outnumbered by the bacteria normally found in the healthy bowel, primary isolation requires the use of a selective medium.  
A. Salmonellae C. Conditions are favorable for growth  
B. Intestinal infections D. None of the Above
17. 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**

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

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

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

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

### **Filamentous Bacteria**

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

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

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

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

### **Site Specific Bacteria**

22. 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**

23. 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

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

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

### **Anaerobic Bacteria**

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

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

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

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

27. A typical use for \_\_\_\_\_ would be in a septic tank.  
A. Aerobic bacteria      C. Facultative bacteria  
B. Anaerobic bacteria    D. None of the Above

28. Which of the following 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

### **Aerobic Bacteria**

29. Aerobic bacteria live and multiply in the presence of free oxygen.  
A. True    B. False

30. Facultative bacteria always achieve an aerobic state when oxygen is present.  
A. True    B. False

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

32. 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**

33. In a wastewater treatment system, the next higher life form above bacteria is?  
A. Nematodes    C. Protozoan(s)  
B. Rotifers      D. None of the Above

34. Which of the following are also indicators of biomass health and effluent quality?  
A. Aerobic flocs                        C. Biomass health and effluent quality  
B. Protozoans                            D. None of the Above

35. Which of the following are very similar to protozoans except that they are usually multi-celled animals?  
A. Nematodes and rotifers            C. Worms  
B. Metazoan(s)                            D. None of the Above

36. Which of the following and the relative abundance of certain species can be a predictor of operational changes within a treatment plant?  
A. Nematodes and rotifers            C. Protozoans and metazoans  
B. Macroinvertebrates                D. None of the Above

### **Dispersed Growth**

37. 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

38. 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.**

39. 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
40. 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
41. 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

**Activated Sludge Bugs**

42. 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
43. 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
44. 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
45. 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
46. 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

47. 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                      C. Total Dissolved Solids  
B. Organic compounds    D. None of the Above
48. 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    C. Bacteria  
B. Compound    D. None of the Above
49. 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    C. Activated sludge  
B. Oxidation        D. None of the Above
50. 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                      C. Non-organic solids and biomass  
B. Floc                                      D. None of the Above
51. What does facultative mean as far as bugs? What environments are they adaptable to survive and multiply in?
- A. Aerobic only                      C. Either anaerobic or aerobic conditions  
B. Anaerobic only                      D. None of the Above
52. 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    C. Solids biomass  
B. RAS                      D. None of the Above
53. We need to be able to properly identify the bugs and which commonly found bug is a medium size to large swimming Ciliate, commonly observed in activated sludge, sometimes in abundant numbers.
- A. Vorticella                      C. Paramecium  
B. Euglypha                      D. None of the Above
- Vorticella sp.**
54. Which of the following bugs feeds by producing a vortex with its feeding cilia?
- A. Shelled amoeba(s)    C. Euglypha  
B. Vorticella                      D. None of the Above
55. According to the text, if treatment conditions are bad, for example, low DO or toxicity, \_\_\_\_\_ will leave their stalks.
- A. Shelled amoeba(s)    C. Vorticella  
B. Euglypha                      D. None of the Above

**Euglypha sp.**

56. 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

57. 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

58. 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.**

59. 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

60. Euchlanis is a typical?

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

61. Which of the following bugs is an omnivore, meaning that its varied diet includes detritus, bacteria, and small protozoa?

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

62. Which of the following bugs has a glassy shell secreted by its outer skin?

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

63. A characteristic of this creature is their mastax?

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

64. According to the text, Euchlanis is commonly found in?

- A. Biofilm
- B. Biogrowth
- C. Activated sludge
- D. None of the Above

**Activated Sludge Aerobic Flocs**

65. 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:**

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

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

67. Which of the following wastewater treatment related terms occurs when sludge that normally settles rises back to the surface after having settled?

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

68. 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
- B. Organic material
- C. Bulking sludge
- D. None of the Above

**Filamentous Organisms**

69. Which of the following wastewater treatment related terms reach too high a concentration, they can extend dramatically from the floc particles?

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

**Filamentous Bacteria Identification**

70. 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

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

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

72. *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

73. According to the text, *Thiothrix* II produces rectangular filaments up to 200 microns in length and is easily identified by their \_\_\_\_\_ using phase contrast microscopy at 400 to 1000x magnification.

- A. Stain gram-negative
- B. Not casease
- C. Starburst effect formations
- D. None of the Above

***Microthrix parvicella***

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

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

### **Sphaeroliticus natans**

75. 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

76. Cells are straight to slightly curved, up to 1000 microns in length and?

A. Stain gram-negative C. Disruptive foaming  
B. Not casease D. None of the Above

77. A low F/M ratio favors filamentous organisms, because their higher ratio of surface area to volume provides them with a selective advantage for?

A. Viscous brown color C. Securing nutrients in nutrient limited environments  
B. Staining gram-positive D. None of the Above

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

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

### **Filamentous Bacteria**

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

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

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

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

### **Other Wastewater Treatment Components**

#### **Biochemical Oxygen Demand**

81. Biochemical Oxygen Demand (BOD or BOD5) is an indirect measure of Biodegradable organic compounds in water, and is determined by measuring the dissolved oxygen decrease in a controlled water sample over a five-day period.

A. True B. False

82. During this five-day period, aerobic (oxygen-consuming) bacteria decompose organic matter in the sample and consume dissolved oxygen in proportion to the amount of organic material that is present.

A. True B. False

83. Which of the following reflects high concentrations of substances that can be biologically degraded, thereby consuming oxygen?

A. Organic carbon C. High BOD  
B. Human sources D. Total Suspended solids

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 C. MLSS  
B. CBOD D. MLVSS

## pH

85. The acidity or alkalinity of wastewater affects both treatment and the environment. Low  
A. True B. False

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

87. Other substances and some acids can alter \_\_\_\_\_ can inactivate treatment processes when they enter wastewater from industrial or commercial sources.  
A. Total Solids C. Total Suspended solids  
B. TDS D. pH

## Total Dissolved Solids

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

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

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

91. TDS in drinking water originate from natural sources, sewage, urban run-off, industrial wastewater, and chemicals used in the water treatment process.  
A. True B. False

92. The total dissolved solids test provides a qualitative measure of the amount of dissolved ions, but does not tell us the nature or ion relationships.  
A. True B. False

93. Which of the following wastewater terms has been due to natural environmental features such as: mineral springs, carbonate deposits, salt deposits, and seawater intrusion?  
A. Total Solids C. Total Suspended solids  
B. TDS D. Alkalinity

94. Which of the following wastewater terms is the concentration is the sum of the cations (positively charged) and anions (negatively charged) ions in the water?  
A. Treatment processes C. Alkalinity  
B. Total dissolved solids (TDS) D. pH

95. 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**

96. 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

97. 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

98. 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

99. 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

100. 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)**

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

- A. True
- B. False

102. 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

103. 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

104. 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

105. 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    C. Total Suspended solids  
 B. TDS              D. Alkalinity
106. Which of the following wastewater terms can block light from reaching submerged vegetation?  
 A. Oxygen                      C. Settling sediments  
 B. High TSS                    D. Suspended sediment
107. 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
108. If light is completely blocked from bottom dwelling plants, the plants will stop producing oxygen and will die.  
 A. True    B. False
109. The main focus of wastewater treatment plants is to reduce \_\_\_\_\_ in the effluent discharged to natural waters, meeting state and federal discharge criteria.  
 A. BOD and COD                      C. Soluble nutrients  
 B. Some contaminants                D. Oxygen and organic waste
110. Treatment of wastewater usually involves \_\_\_\_\_ such as the activated sludge system in the secondary stage after preliminary screening.  
 A. Biological processes                C. Application-specific microbiology  
 B. Activated sludge system            D. Pretreatment and pollution prevention
111. These secondary treatment steps that harness natural self-purification processes contained in bioreactors for the biodegradation of organic matter and bioconversion of \_\_\_\_\_ in the wastewater.  
 A. Biofilm                                C. Soluble nutrients  
 B. Some contaminants                D. Oxygen and organic waste

**Water Quality Criteria**

112. 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
113. 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

114. 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

115. Allowable concentrations provide protection for plants and animals that are found in surface waters.  
A. True B. False

116. Allowable concentrations are designed to provide protection for both freshwater and saltwater aquatic organisms from the effects of acute (short-term) and chronic (long-term) exposure to potentially harmful chemicals.  
A. True B. False

117. Which of the following wastewater treatment terms is based upon toxicity information and developed to protect aquatic organisms from death, slower growth, reduced reproduction, and the accumulation of harmful levels of toxic chemicals in their tissues that may adversely affect consumers of such organisms?  
A. Aquatic life criteria C. Concentration of pollutant(s) criteria  
B. Water pollutant(s) criteria D. A pollutant level criteria

### Biological Criteria

118. 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

119. 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

120. 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

121. In a single aerobic system, members of the genera Pseudomonas, Nocardia, Flavobacterium, Achromobacter and Zooglea may be present, together with filamentous organisms.  
A. True B. False

122. In a well-functioning system, protozoas and rotifers are usually present and are useful in consuming dispersed \_\_\_\_\_ or non-settling particles.  
A. Bacteria C. Suspended growth processes  
B. Attached growth processes D. Food-to-microorganism ratio, F/M

123. The organic load present is incorporated in part as represented by \_\_\_\_\_ by the microbial populations, and almost all the rest is liberated as gas.

- A. Biological denitrification
- B. Organic load
- C. Biomass
- D. Aerobic and facultative microorganisms

124. Unless the cell mass formed during the biological treatment is removed from the wastewater the treatment is largely incomplete, because the biomass itself will appear as organic load in the effluent and the only pollution reduction accomplished is that fraction liberated as gases.

- A. True
- B. False

125. The biological treatment processes used for wastewater treatment are broadly classified as aerobic in which aerobic and facultative microorganisms predominate or anaerobic which use \_\_\_\_\_?

- A. Aerobic microorganism
- B. Organic load
- C. Anaerobic microorganism
- D. Aerobic and facultative microorganisms

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
- B. Attached growth processes
- C. Suspended 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. The saprophytes exist on dead or decaying materials.

- A. True
- B. False

133. 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
134. Aerobic bacteria do not require oxygen to live and thrive.  
A. True B. False
135. Aerobes decompose inorganics in the water; the result is carbon dioxide and H<sub>2</sub>SO<sub>4</sub>.  
A. True B. False
136. Dissolved oxygen (DO) in water is considered a contaminant.  
A. True B. False
137. Dissolved oxygen level is important because too much or not enough dissolved oxygen can create \_\_\_\_\_?  
A. Unfavorable conditions C. Frequent dissolved oxygen measurement  
B. DO analysis D. None of the Above
138. A lack of Dissolved oxygen in natural waters creates?  
A. Anaerobic conditions C. Aerobic Conditions  
B. Denitrification 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 C. VFAs  
B. Methane fermenters 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. The Sludge Volume Index (SVI) of activated sludge is defined as the volume in milliliters occupied by \_\_\_\_\_ after settling for 30 minutes.  
A. Optimal DO levels C. A portion of the effluent  
B. 1g of activated sludge D. None of the Above

### 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) C. Grit and sand  
B. Finer debris 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 C. Primary sludge  
B. Wastewater effluent 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)                      C. Dissolved organic and inorganic constituents  
B. Suspended solids         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                      C. Very fine solids  
B. TDS                                 D. None of the Above

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

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

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

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

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

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

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

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

### 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 recirculated to Tanks as Return Sludge to help sustain the microorganism population in the?

- A. Trickling filter(s)                C. Recirculating sand filters (RSFs)  
B. Oxidation Ditches                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 -this missing term- and microorganisms in the wastewater to renovate sewage.

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

### 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 C. Heterotrophic bacteria  
B. Predators 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 C. Stalked ciliate(s)  
B. Aerobic bacteria D. None of the Above

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

A. Floc-forming bacteria C. Nitrobacters  
B. Swimming ciliates 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) C. Floc-forming bacteria  
B. Aerobic bacteria D. None of the Above

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

A. Strict aerobes C. Microorganism numbers  
B. Predators 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 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, termed?

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

### **Aerated lagoons**

184. 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

185. 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

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

A. True B. False

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

A. True B. False

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

A. True B. False

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

A. True B. False

194. Saprophytic bacteria thrive without the presence of oxygen.

A. True B. False

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

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

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

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

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
- C. Acid-forming bacteria
- B. Methane 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
- B. Sulfur bacteria
- C. Acid-forming 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

## **Topic 5 – Nutrient Section**

### **Total Kjeldahl Nitrogen**

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

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

249. 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

250. Inert means the material is safe for all microorganisms.  
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
- B. Total ammonia
- C. Phosphate
- 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.  $\mu\text{g/l}$
- B. mg/l/day
- C. As N, mg/l
- 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. 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

265. 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

266. 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

### **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
- B. Phosphorus
- C. Soluble biodegradable phosphorus
- D. Particulate organically bound phosphorus

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

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

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

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

### Biological Phosphorus Control

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
- B. Phosphorus
- C. Both nitrogen and 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
- B. Phosphorus
- C. Both nitrogen and 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
- B. Phosphorus
- C. Phosphoric acid, phosphate ion
- 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

283. Achieving effluent phosphorus concentrations below 50 mg/L as P depends upon getting good solid removal in the secondary clarifiers.

- A. True
- B. False

284. Solids that escape into the final effluent generally do not contain Nitrogen and phosphorus.

- A. True
- B. False

285. Many WWTPs are equipped with advanced or tertiary filters to ensure solids capture.

- A. True
- B. False

### Biological Phosphorus Removal and Combination Processes

#### Principles

286. 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

287. Phosphorus is released in this zone providing energy for uptake of VFAs that are polymerized and stored inside the PAO cells.

- A. True B. False

### **Fuhs & Chen Theory**

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

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

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

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

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

290. The \_\_\_\_\_ is returned from the clarifier to the anoxic zone instead of the anaerobic zone to allow for denitrification and to avoid interference from nitrate with the activation of the PAOs in the anaerobic stage.

- A. RAS C. A nitrate-rich liquor  
B. WAS D. Denitrified mixed liquor

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

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

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

### **Oxidation Ditches**

292. There are several oxidation ditch designs that can remove phosphorus. They normally consist of an anaerobic zone ahead of the oxidation ditch whereas simultaneous \_\_\_\_\_ takes place within the ditches.

- A. Anaerobic C. Nitrification and denitrification  
B. Oxidation D. Anaerobic and aerobic zones

293. Oxidation ditches typically operate as racetrack configurations around a central barrier, with forward \_\_\_\_\_ flows of approximately 1 foot per second or more. It is possible, by manipulating the DO transferred to the mixed liquor, to establish both anoxic, aerobic and near anaerobic zones within the racetrack configuration, even though the high flow velocities accomplish complete mixing of the wastewater with the RAS.

- A. Mixed liquor C. DO  
B. RAS D. WAS

### Sequencing Batch Reactors (SBR)

294. SBRs are fill-and-draw reactors that operate sequentially through the various phases by means of adjusting the mixing and aeration. The \_\_\_\_\_ can be set and automated to allow the mixed liquor to go through an anaerobic/anoxic/aerobic progression as is necessary for removal of phosphorus and nitrates.

- A. Supernatant stream    C. Primary sedimentation  
B. Reactor phases        D. Secondary clarifier

295. Because of the fill-and-draw nature of SBRs, it actually is necessary to remove the nitrates remaining from the previous cycle before anaerobic conditions can be established, thus the typical treatment progression becomes\_\_\_\_\_.

- A. Anaerobic zone        C. Anoxic/anaerobic/aerobic  
B. Oxidized                D. Anaerobic and aerobic zones

### Principles

296. Chemical precipitation for phosphorus removal is reliable wastewater treatment method that has not significantly changed over the years. To achieve removal, coagulant aids such as sodium hydroxide are added to wastewater where they react with soluble phosphates to form mixed liquor.

- A. True    B. False

297. Chemical precipitation is typically accomplished using either lime or a metal salt such as aluminum sulfate (alum) or as mentioned iron salts such as ferric chloride. The addition of polymers and other substances can further enhance floc formation and solids settling.

- A. True    B. False

298. Plant operators can use existing secondary clarifiers or retrofit primary clarifiers for removal of sludge.

- A. True    B. False

### Chemical Dose

299. The required chemical dose is related to the liquid phosphorus concentration. For target concentrations above 20 mg/L (appropriate for chemical addition to a primary clarifier), a dose of 10 moles of aluminum or iron per mole of phosphorus is sufficient.

- A. True    B. False

### Aluminum and Iron Salts

300. Alum and ferric or ferrous salts are commonly used as coagulant and settling aids in both the water and wastewater industry. Ferric is less corrosive than Alum without drastic changes to pH, creates less sludge, and is more popular with operators when compared to lime which increases the pH.

- A. True    B. False