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Wastewater Treatment _____ Other _____

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

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| 1. A B C D | 17. A B C D | 33. A B C D | 49. A B C D |
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| 76. A B C D | 108. A B C D | 140. A B C D | 172. A B |
| 77. A B C D | 109. A B C D | 141. A B C D | 173. A B C D |
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| 86. A B | 118. A B | 150. A B C D | 182. A B C D |
| 87. A B | 119. A B | 151. A B | 183. A B C D |
| 88. A B | 120. A B | 152. A B C D | 184. A B C D |
| 89. A B | 121. A B | 153. A B | 185. A B C D |
| 90. A B | 122. A B | 154. A B | 186. A B |
| 91. A B | 123. A B | 155. A B | 187. A B |
| 92. A B | 124. A B | 156. A B | 188. A B |
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| 199. A B | 231. A B C D | 263. A B C D | 295. A B C D |
| 200. A B C D | 232. A B C D | 264. A B C D | 296. A B C D |
| 201. A B C D | 233. A B C D | 265. A B | 297. A B C D |
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| 209. A B C D | 241. A B C D | 273. A B | 305. A B C D |
| 210. A B C D | 242. A B C D | 274. A B | 306. A B C D |
| 211. A B C D | 243. A B C D | 275. A B C D | 307. A B C D |
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| 213. A B | 245. A B C D | 277. A B C D | 309. A B |
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325. A B C D	345. A B	365. A B C D	385. A B C D
326. A B C D	346. A B C D	366. A B	386. A B C D
327. A B C D	347. A B C D	367. A B C D	387. A B C D
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329. A B C D	349. A B C D	369. A B C D	389. A B C D
330. A B C D	350. A B C D	370. A B C D	390. A B C D
331. A B C D	351. A B C D	371. A B C D	391. A B C D
332. A B C D	352. A B C D	372. A B C D	392. A B C D
333. A B C D	353. A B C D	373. A B C D	393. A B C D
334. A B C D	354. A B C D	374. A B C D	394. A B C D
335. A B C D	355. A B C D	375. A B C D	395. A B C D
336. A B C D	356. A B C D	376. A B C D	396. A B C D
337. A B C D	357. A B C D	377. A B C D	397. A B C D
338. A B C D	358. A B	378. A B C D	398. A B C D
339. A B C D	359. A B C D	379. A B C D	399. A B C D
340. A B C D	360. A B C D	380. A B C D	400. A B C D

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Tertiary Treatment

CEU Course Assignment

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

You will have 90 days from the start of this course to complete in order to receive your Professional Development Hours (**PDHs**) or Continuing Education Unit (**CEU**). A score of 70 % is necessary to pass this course. If you should need any assistance, please email all concerns and the completed manual to info@tlch2o.com.

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

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

Please write down any problem questions.

Basic Wastewater Treatment Processes

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

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

Biological

2. 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

3. The bacteria normally present in wastewater must have oxygen to do their part in breaking down the sewage.

- A. True
- B. False

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

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

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

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

Chemical

6. Which of the following wastewater terms are often used at the later stages of treatment to improve the settling of excess microbiological growth or biosolids?

- A. Polymers
- B. Activated Sludge
- C. Methenol
- D. None of the Above

7. According to the text, chemicals can be used to create changes in pollutants that increase the removal of these new forms by physical processes.

- A. True
- B. False

Organic Matter

8. Which of the following wastewater terms can cause pollution, if too much of this organic matter in wastewater; it can be devastating to receiving waters?

- A. Iron
- B. Biodegradable material(s)
- C. Organic material(s)
- D. High supply of oxygen

9. 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

10. 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

11. 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

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

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

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

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

Oil and Grease

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

- A. True
- B. False

Inorganics

15. 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

Pollutants, Oxygen-Demanding Substances

16. If the effluent, the treated wastewater produced by a treatment plant, has a high content of organic pollutants or ammonia, it will demand more oxygen from the water and leave the water with less of _____ to support fish and other aquatic life.

- A. pH
- B. Carbon
- C. Carbon Dioxide
- D. Oxygen

Nutrients

17. 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

18. 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

19. 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

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

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

Primary Treatment

21. 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
- B. Trickling ditch
- C. Suspended growth process(es)
- D. Primary and secondary stages

Preliminary Treatment

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

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

Primary Sedimentation

23. 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

24. 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

Other Wastewater Treatment Components

Biochemical Oxygen Demand

25. 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

Application Specific Microbiology

26. Which of the following is the preferred methodology in wastewater treatment affecting the efficiency of biological nutrient removal?
- A. Attached growth C. Application-specific microbiology
B. Advanced treatment technologies D. None of the Above

27. 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

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

Biological Criteria

29. 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. None of the Above

pH

30. The acidity or alkalinity of wastewater affects both treatment and the environment. Low
- A. True B. False
31. pH indicates increasing acidity while a low pH indicates increasing alkalinity.
- A. True B. False

Conventional Wastewater Treatment - Primary Overview

Primary Treatment

32. The initial stage in the treatment of domestic wastewater is known as bar screens.
- A. True B. False
33. 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

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

35. 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

36. 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

37. 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

38. 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

39. 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

40. 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

41. 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

42. 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

43. When the wastewater enters a sedimentation tank, it slows down and the suspended solids gradually sink to the bottom, this mass of solids is called?
A. Very fine solids C. Primary sludge
B. Wastewater effluent D. None of the Above

44. 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

45. 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

46. 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

47. 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

48. 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

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

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

50. 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

51. 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

52. 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

53. 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

Ponds and Lagoon Sub-Section

Lagoon Systems

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

A. True B. False

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

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

Temperature

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

A. True B. False

57. 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

58. Swimming and _____ engulf bacteria or other prey.

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

59. 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

60. Predators feed mostly on stalked and _____.

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

61. 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

62. Food (organic loading) regulates _____?

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

Aerobic Bacteria

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

A. True B. False

64. Which of the following bugs or terms are similar to those found in other treatment processes such as activated sludge?
 A. Treatment organism(s) C. Floc-forming bacteria
 B. Aerobic bacteria D. None of the Above
65. Which of the following bugs or terms degrade wastes grow as single bacteria dispersed in the wastewater?
 A. Strict aerobes C. Many bacterial species
 B. Predators D. None of the Above
66. Which of the following bugs or terms, grow in a large aggregate due to exocellular polymer production?
 A. Predators C. Floc-forming bacteria
 B. Aerobic bacteria D. None of the Above
67. Growth form is important as these flocs degrade _____ and settle at the end of the process, producing a low TSS effluent.
 A. Anaerobic action C. BOD
 B. Application-specific bacteria D. None of the Above
68. Which of the following bugs or terms occur in lagoons, usually at specific growth environments?
 A. Anaerobic action C. A number of filamentous bacteria
 B. Absence of free oxygen D. None of the Above
69. 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 C. Most heterotrophic bacteria
 B. Predators D. None of the Above
70. Anaerobic BOD bacteria are replaced by Mesophilic bacteria at temperatures above 35°C).
 A. True B. False
71. BOD removal increases rapidly below 3-4°C and ceases at 1-2°C.
 A. True B. False
72. 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

73. 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
74. Two types are the most common: The Aerobic-anaerobic or partially suspended lagoon in which the concentration of solids and dissolved oxygen are maintained fairly uniform and neither the incoming solids nor the biomass of microorganisms' settle, and the completely mixed lagoon.
 A. True B. False

75. 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

76. 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. Methane forming bacteria D. None of the Above
77. Anaerobic methane formation involves _____ bacteria.
- A. Three different groups of anaerobic C. Organic overloading conditions
B. Methane fermentation D. None of the Above
78. 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

79. Aerobic is a condition in which free or dissolved oxygen is present in the aquatic environment.
A. True B. False
80. Aerobic Bacteria will live and reproduce only in an environment containing oxygen.
A. True B. False
81. When oxygen chemically combined, such as in water molecules can be used for respiration by aerobes
A. True B. False
82. Anaerobic- a condition in which "free" or dissolved oxygen is not present in the aquatic environment.
A. True B. False
83. Saprophytic bacteria thrive without the presence of oxygen.
A. True B. False
84. Anaerobic Bacteria that break down complex solids to volatile acids.
A. True B. False
85. Methane Fermenters – bacteria that break down the volatile acids to methane, carbon dioxide and water.
A. True B. False
86. 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

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

A. True B. False

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

A. True B. False

Basic System Components of Activated Sludge

89. 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

90. 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, CO₂.

A. True B. False

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

A. True B. False

Nitrification

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

A. True B. False

93. 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

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

A. True B. False

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

A. True B. False

96. 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

Monitoring of Sludge Settleability

Sludge Volume Index (SVI)

97. 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

98. _____ settleability is central to the health of the biological system. It is important to point out that settleability is influenced by conditions in the activated sludge basin but manifests itself in the clarifier.

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

Activated Sludge Methods

Organic Load

99. 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

100. 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

101. 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

102. 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

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

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

104. 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

105. 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

106. 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 $> 14^{\circ} \text{C}$?
- A. Acid-forming bacteria
 - B. Methane bacteria
 - C. Aerobic bacteria
 - D. None of the Above
107. 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
108. 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
109. 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
110. 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
111. 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
112. 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
113. 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

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

Final Clarifier Solids Loading Rate (SLR)

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

Clarifier Sludge Blanket

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

A. True B. False

Filaments

117. 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

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

A. True B. False

Pin Floc

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

A. True B. False

Sludge Age

120. 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

121. 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)

122. 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

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

A. True B. False

Extended Aeration Activated Sludge Plants

124. 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

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

A. True B. False

Young Sludge

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

A. True B. False

Excessive Old Sludge

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

A. True B. False

Return Rates Too Low

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

A. True B. False

Return Rates Too High

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

A. True B. False

Denitrification in Final Clarifier

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

A. True B. False

Old Sludge

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

A. True B. False

Stable Nitrification

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

A. True B. False

Slimy Foam

133. 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

134. 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

135. 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

136. 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)

137. 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

Nitrogen Introduction

138. The major contributors of nitrogen to wastewater are _____ such as food preparation, showering, and waste excretion.
A. Human activities C. Bacteria and other microbes
B. Oxygen-demanding pollutants D. None of the Above
139. The per capita contribution of nitrogen in domestic wastewater is about 1/10th of that for BOD.
A. True B. False

140. 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

141. 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:

142. Digestion to convert organic nitrogen to?

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

151. The chemical composition of DON in wastewater effluents is completely understood.

- A. True
- B. False

Phosphorus

152. Which of the following in domestic wastewater typically ranges between 4 and 8 mg/L but can be higher depending on sources?

- A. Phosphorus as phosphate C. Total phosphorus (TP)
B. Orthophosphate D. None of the Above

Total Kjeldahl Nitrogen

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

- A. True B. False

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

- A. True B. False

155. 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

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

- A. True B. False

Ammonia

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

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

158. 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

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

- A. True B. False

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

- A. True B. False

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

- A. True B. False

Nitrifying Bacteria

162. 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

163. AOB and NOB are classified as autotrophic bacteria because they derive energy from the oxidation of reduced inorganic compounds (in this case, nitrogenous compounds) and use inorganic carbon (CO_2) as a food source.

A. True B. False

Significant Amount of Oxygen

164. 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

165. 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

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

A. True B. False

Total Inorganic Nitrogen (TIN)

167. 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

168. 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

169. 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

170. 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

171. 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

172. 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

173. 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

174. 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)

175. 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

176. _____ 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

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

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

178. _____ 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

179. 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)

180. 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

181. 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

182. 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

183. 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

184. 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

185. 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

186. 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

187. 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

188. 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

189. 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

190. PAOs have the ability to store a large mass of _____ in their cells in the form of polyphosphates.
A. Carbon C. Poly- β -hydroxybutyrate (PHB)
B. Phosphorus D. Magnesium and potassium ions

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

191. The UCT process was designed to reduce _____ to the anaerobic zone when high removal of nitrates in the effluent is not required. It consists of three stages: an anaerobic stage, an anoxic stage, and an aerobic stage.
A. Nitrates C. An anoxic zone
B. A nitrate rich stream D. An aerobic stage

Johannesburg (JHB), Modified Johannesburg and Westbank

192. 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

Topic 6- Wastewater Microbiology Section

Bacteria Section

193. 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

194. 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

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

196. 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

197. 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

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

A. True B. False

199. 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

Salmonella

200. 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

201. 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

202. 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

Filamentous Bacteria

203. 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

204. 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

Site Specific Bacteria

205. 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

206. 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

207. 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

208. 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

209. 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

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

211. 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

Aerobic Bacteria

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

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

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

215. 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

216. 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

217. 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

218. 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

219. 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

Dispersed Growth

220. 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

221. 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.

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

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

223. 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

224. 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

225. 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

226. 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

227. 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

228. 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

229. 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

230. 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

231. 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

232. 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

233. 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

234. 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

235. 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

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

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

Vorticella sp.

237. 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

238. 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.

239. 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

240. 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

241. 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.

242. 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

243. Euchlanis is a typical?

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

Activated Sludge Aerobic Flocs

244. 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:

245. 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

246. 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

247. 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

248. 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

249. 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

250. 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

251. 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

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

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

Sphaeroliticus natans

253. *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

254. 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

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

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

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

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

Biological Criteria Sub-Section

Water Quality Criteria

257. 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

258. 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

259. 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

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

- A. True
- B. False

Biological Criteria

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

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

262. 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
- B. Harmful effects of pollution
- C. Acute (short term) and chronic (long term)
- D. Human health and aquatic life criteria

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

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

Genera

264. 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

265. The most common aerobic processes are: activated sludge systems, lagoons, trickling filters and rotating disk contactors.
- A. True B. False

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

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

267. 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 C. Mean cell residence time (MCRT)
B. Attached growth processes D. DO analysis

Topic 8- Laboratory Analysis and Process Control

Dissolved Oxygen Testing Section

Iodometric Test

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

- A. True B. False

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

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

270. Which of the following wastewater terms can liberate iodine from iodides, and some reducing agents reduce iodine to iodide?

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

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

272. Which of the following wastewater terms is highly dependent on the source and characteristics of the sample?

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

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

- A. True B. False

274. 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

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

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

276. According to the text, membrane electrodes provide an excellent method for _____ in polluted, highly colored turbid waters and strong waste effluents.

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

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

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

278. Which of the following wastewater terms –is the one of the most important analyses in determining the quality of natural waters?

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

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

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

Sludge Volume Index (SVI)

280. 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

281. 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 C. 10 g of activated sludge
B. 5g of activated sludge D. None of the Above

Dissolved Oxygen Testing Section

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

- A. True B. False

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

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

284. The saprophytes exist on dead or decaying materials.
A. True B. False
285. 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
286. Aerobic bacteria do not require oxygen to live and thrive.
A. True B. False
287. Aerobes decompose inorganics in the water; the result is carbon dioxide and H₂SO₄.
A. True B. False
288. Dissolved oxygen (DO) in water is considered a contaminant.
A. True B. False
289. 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
290. A lack of Dissolved oxygen in natural waters creates?
A. Anaerobic conditions C. Aerobic Conditions
B. Denitrification D. None of the Above
291. 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
292. 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

Total Dissolved Solids

293. Pure water is tasteless, colorless, and odorless and is often called the universal solvent.
A. True B. False
294. 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
295. 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

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

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

Total Solids

297. 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

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

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

299. 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

300. 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

301. 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)

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

- A. True
- B. False

303. 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

304. 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

305. 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

306. 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

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

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

308. 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

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

- A. True
- B. False

Settleometer Test

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

- A. True
- B. False

311. 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

312. 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

313. 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

314. 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

315. 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

316. 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

Advanced Treatment Section

Types of Processes

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

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

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

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

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

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

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

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

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

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

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 cm²?

- 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^{2+} , Mg^{2+}) while passing smaller hydrated monovalent ions?

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

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
- B. Gentle molecular separation
- C. Organic solvent nanofiltration technology
- 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
- B. Gentle molecular separation
- C. Organic solvent nanofiltration technology
- 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
- B. Microfiltration or MF
- C. Nanofiltration
- D. None of the Above

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

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

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

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

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
- B. Microfiltration or MF
- C. Nanofiltration
- 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
- B. Microfiltration or MF
- C. Nanofiltration
- 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
- B. Microfiltration or MF
- C. RO
- 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
- B. Osmotic pressure
- C. Virtually 100% of colloidal and suspended matter
- D. None of the Above

369. The higher the content of dissolved solids, the higher the?

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

370. Which of the following result in higher osmotic pressures?

- A. Pressure differential
- B. Osmotic pressure
- C. Higher molecular weights
- 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
- B. A pressure of 10 PSI
- C. 1.68 Bar
- 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
- B. A pressure of 10 PSI
- C. 1.68 Bar
- 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
- B. A pressure of 10 PSI
- C. 1.68 Bar
- 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
- B. Microporous support layer
- C. The concentrate
- 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
- B. Microporous support layer
- C. The concentrate
- 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
- B. Microporous support layer
- C. The concentrate
- 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
- B. Microporous support layer
- C. Amount of permeate or product water
- D. None of the Above

378. To achieve Reverse Osmosis, the _____ pressure is generally doubled.

- A. Membrane material
- B. Osmotic
- C. Amount of permeate or product water
- 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. Alternatively, 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
- B. Potable water treatment
- C. Direct filtration process
- 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 C. Electricity
 B. Concentrate D. None of the Above