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Activated Sludge Answer Key

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Activated Sludge CEU Training Course Assignment

The Assignment (Exam) is also available in Word on the Internet for your Convenience, please visit www.ABCTLC.com and download the assignment and e-mail it back to TLC.

You will have 90 days from the start of this course to complete in order to receive your Professional Development Hours (**PDHs**) or Continuing Education Unit (**CEU**). A score of 70 % is necessary to pass this course. We prefer if this exam is proctored. No intentional trick questions. If you should need any assistance, please email all concerns and the completed manual to info@tlch2o.com.

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Hyperlink to the Glossary and Appendix
http://www.abctlc.com/downloads/PDF/WWTGlossary.pdf

Organic Matter

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

A. BOD C. CORP
B. MLSS D. None of the Above

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

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

3. Large amounts of biodegradable materials can lower or deplete the _____in the water needed by aquatic life.

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

Oil and Grease

4. When large amounts of oils and greases are discharged, these increase _____and they may float to the surface and harden, causing aesthetically unpleasing conditions.

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

Nutrients

5. Which of the following are necessary to living organisms and are the chief nutrients present in natural water?

A. Hydrogen C. Carbon, nitrogen, and phosphorus
B. Carbon dioxide D. Answers A,B and C

6. Primarily _____but occasionally nitrogen, causes nutrient enrichment which results in excessive growth of algae.
A. Phosphorus C. Ammonia
B. Nitrifying Bacteria D. Calcium Hydroxide

Inorganic and Synthetic Organic Chemicals
7. Inorganic and synthetic organic chemicals can cause _____ problems, and many are not effectively removed by conventional wastewater treatment.
A. Toxicological C. Excessive growth of aerobic bacteria
B. Ecological D. Taste and odor

Biological Components Section Introduction
Biochemical Oxygen Demand
8. 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
9. 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

Primary Wastewater Treatment Section

Conventional A/S Wastewater Treatment Plant Overview
Primary Treatment
10. 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

11. 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
12. 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

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

14. 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

Primary Sedimentation

15. 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

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

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

Topic 3 - Secondary Treatment Section

Secondary Treatment

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

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

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

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

19. Which of the following form larger and heavier aggregates that can by physically separated?

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

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

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

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

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

Lagoon Microorganisms Introduction

22. Which of the following 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

23. Which of the following degrade wastes and grows as single bacteria dispersed in the wastewater?

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

24. Which of the following grow in a large aggregate due to exocellular polymer production?
A. Predators C. Floc-forming bacteria
B. Aerobic bacteria D. None of the Above

25. 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

26. 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

27. Which of the following have a wide range in environmental tolerance and can function effectively in BOD removal over a wide range in pH and temperature?
A. Strict aerobes C. Most heterotrophic bacteria
B. Predators D. None of the Above

28. 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

Advanced Methods of Wastewater Treatment

29. As our country and the demand for clean water have grown, it has become more important to produce cleaner wastewater effluents, yet _____ are more difficult to remove than others.
A. Biofilm C. Soluble nutrients
B. Some contaminants D. None of the Above

30. All WWTPs provide a minimum of?
A. Biofilm and chemical removal C. Pretreatment and pollution prevention
B. Secondary treatment D. None of the Above

Advanced Treatment Technologies

31. Advanced treatment may include physical-chemical separation techniques such as adsorption, flocculation/precipitation, membranes for advanced filtration, _____, and reverse osmosis.
A. Denitrification process C. Ion exchange
B. Organic material D. None of the Above

Activated Sludge Process Section

Regular MLSS Removal

32. To maintain a stable treatment process, MLSS must be removed on a regular schedule. The MLSS can be removed from the bottom of the clarifier or from the_____.
A. Secondary sludge wasting C. Activated sludge basin
B. Solids handling process D. None of the above

33. The _____ removed directly from the basin is renamed as WAS.
A. MLSS C. WAS
B. CRT D. None of the above

34. Some clarifiers have separate pipelines for RAS and WAS. In other cases, WAS is pumped out of the _____pipeline.
A. RAS C. WAS
B. CRT D. None of the above

Wasting Rates
35. CRT is defined as the average length of time in days that an organism remains in the _____.
A. Secondary treatment system C. Many activated sludge plants
B. Solids handling process D. None of the above

36. The operator determines the operating _____ for the facility and maintains it through wasting the appropriate amount of excess biomass (Waste Activated Sludge, WAS) from the secondary system.
A. Mixed Liquor C. WAS
B. CRT D. None of the above

37. The amount of _____in the secondary system is controlled and maintained through solids wasting.
A. Biomass (MLSS) C. WAS
B. CRT D. None of the above

38. In nearly all activated sludge plants, wasting is accomplished by directing a portion of the Return Sludge to the_____.
A. Secondary sludge wasting C. Many activated sludge plants
B. Solids handing facility D. None of the above

39. Wasting Return Sludge rather than _____ minimizes the volume of water that must be processed by the sludge thickening/dewatering equipment.
A. Mixed Liquor C. RAS
B. CRT D. None of the above

40. If intermittent wasting is practiced, it is usually best to waste over as long a time period as practical, and when the loading on the _____ is at the low point of the day.
A. Secondary system C. Many activated sludge plants
B. Solids handling process D. None of the above

41. Drastic changes should not be made in wasting rates from one day to the next; allow the _____time to acclimate to a change before another change is made.
A. Secondary sludge wasting C. Advanced system
B. Biological system D. None of the above

42. Consistency is a key element in successful _____ operation.
A. Secondary system C. Activated sludge plant
B. The operator D. None of the above

43. Many activated sludge plants were originally designed to waste secondary solids into the primary clarifiers. The reasoning was that as the less dense biological solids co-settle with the _____the combined sludge density would be increased.
A. Mixed Liquor C. Scum
B. Heavier primary solids D. None of the above

44. A more efficient operation will result if the WAS is wasted directly to a _____ and not allowed to return to the treatment system.
A. Secondary sludge wasting C. Many activated sludge plants
B. Solids handling process D. None of the above

45. It is crucial that adequate solids concentrating equipment and _____are part of any plans for building or expanding an activated sludge plant.
A. Secondary system C. Solids storage capability
B. The operator D. None of the above

46. Which of the following is one of the most important controls available to the operator because it controls the most important aspect of treatment, biomass population?
A. Secondary system C. Activated sludge plant
B. Secondary sludge wasting D. None of the above

47. A good _____ control situation is one that allows the operator to set a totalizer which determines the maximum number of gallons wasted in a particular day and also allows the operator to control and monitor the WAS flow rate.
A. MLSS concentration C. BOD, nutrients, and oxygen
B. WAS D. None of the above

Environmental Conditions
48. Waste activated sludge flow, along with environmental conditions such as water temperature and accessibility to _____, influences the influences the process biology and level of treatment achieved.
A. MLSS concentration C. BOD, nutrients, and oxygen
B. WAS D. None of the above

49. Slower growing microorganisms, including the nitrification bacteria and some bacteria and some filaments, can only remain in the treatment process if the _____ is held long enough for them to reproduce.
A. MLSS C. BOD, nutrients, and oxygen
B. WAS D. None of the above

Sludge Settling
50. Waste activated sludge determines how long the _____ stays in the system and, therefore, helps to determine which type of microorganisms will be present.
A. MLSS C. BOD, nutrients, and oxygen
B. WAS D. None of the above

51. The presence or absence of _____will influence how fast the sludge settles in the clarifier.
A. MLSS concentration C. Filaments
B. WAS D. None of the above

52. Waste activated sludge also determines the _____.
A. MLSS concentration C. BOD, nutrients, and oxygen
B. WAS D. None of the above

Organic Load

53. 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

54. 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

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

A. True B. False

Common Types

56. 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

Sludge Problems and Solutions Section

Excess Solids

57. 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)

58. 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

Pin Floc

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

A. True B. False

Sludge Age

60. 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

61. 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)
62. 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
63. The concentration of WAS has a direct bearing on how much to waste and the volume wasted. On a volume basis, a thicker waste activated sludge (low WAS concentration) will require more amount of wasting than a thinner waste activated sludge (high WAS concentration).
A. True B. False

Extended Aeration Activated Sludge Plants
64. 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
65. 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
66. 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
67. Oxidation ditches are typically limited mix systems, and cannot be modified to approach plug flow conditions.
A. True B. False

Clarifier Sludge Blanket
68. 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
69. 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
70. 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
71. 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
72. A sludge blanket in the final clarifier and a thick return activated sludge.
A. True B. False

Denitrification in Final Clarifier
73. 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
74. 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
75. At a water temperature of 20^{o}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

Denitrification
76. 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)
77. For microbiological health and effective treatment, the microorganisms (mixed liquor suspended solids) under aeration should be maintained at a certain level for the amount of food (influent BOD) coming into the plant. This is known as the_____.
A. MLSS C. Food to microorganism ratio
B. CBOD D. WAS

Slimy Foam
78. 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

79. 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

80. 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

Nutrient Section

TKN

81. 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

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

A. True B. False

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

A. True B. False

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

A. True B. False

Ammonia

85. 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

86. 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. µg/l C. As N, mg/l
B. mg/l/day D. mg/l

Nitrification

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

A. True B. False

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

A. True B. False

89. Ammonia-nitrogen (NH_3-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
90. Ammonia can be converted into nitrite and nitrate by nitrifying bacteria. Effluent ammonia-nitrogen (NH_3-N) concentrations less than 1 mg/L NH_3-N are achievable.
A. True B. False

Autotrophic Bacteria
91. 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
92. 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
93. 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

94. Nitrate removal is limited by the amount of COD available.
A. True B. False

Total Inorganic Nitrogen (TIN)
95. 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
96. 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

97. 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
98. 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

99. 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

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

Phosphorus Section
101. 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

102. 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)

103. 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

104. _____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

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

106. _____ 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
107. 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)

108. PAOs accomplish removal of phosphate by accumulating it within their cells as _____.

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

Production of Polyphosphate

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

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

Luxury Uptake

110. 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 C. Carbon and energy
B. VFAs D. ATP

111. 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 C. Carbon and energy
B. VFAs D. ATP

Logistical Problem

112. The PAOs have a logistical problem: When PAOs are under anaerobic conditions, they are exposes to _____, but without oxygen, nitrite or nitrate present, they cannot access them.

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

Adenosine Triphosphate (ATP) Energy

113. 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 C. Carbon and energy
B. VFAs D. ATP

Chemical Precipitation of Phosphorus

114. 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

115. 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

116. 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
117. 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

Nitrification and Nutrient Removal Sub-Section
118. 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

119. 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

120. Complete nitrification would be expected at pond pH values between pH _____.
A. 7.5 and 9.5 C. 6.0 and 7.5
B. 7.0 and 8.5 D. None of the Above

121. Nitrification ceases at pH values above pH _____ and declines markedly at pH values below _____.
A. 9 and 6 C. 9 and 7
B. 8 and 5 D. None of the Above

122. Nitrification, however, is not a major pathway for nitrogen removal in lagoons. Nitrifying bacteria exists in low numbers in lagoons. They prefer _____and/or high MLSS sludge systems.
A. Nitrifying bacteria C. Attached growth systems
B. Low MLSS sludge systems D. None of the Above

123. Which of the following 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

124. Anaerobic methane formation involves _____bacteria.
A. Three different groups of anaerobic C. Organic overloading conditions
B. Methane fermentation D. None of the Above

125. Which of the following 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

Photosynthetic Organisms
126. Which of the following 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

127. Which of the following 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

128. Which of the following are environmentally sensitive and have a narrow pH range of 6.5-7.5 and require temperatures > 14^{o} C.
A. Acid-forming bacteria C. Aerobic bacteria
B. Methane bacteria D. None of the Above

129. Which of the following that the products of these bugs become the substrate for the methane producers?
A. Acid formers (principally acetic acid) C. Aerobic bacteria
B. Methane bacteria D. None of the Above

130. Which of the following ceases at cold temperature?
A. Acid-forming bacteria C. Aerobic bacteria
B. Methane fermentation D. None of the Above

131. Which of the following can use sulfate as an electron acceptor, reducing sulfate to hydrogen sulfide?
A. Nitrifying bacteria C. Sulfate reducing bacteria
B. Methane forming bacteria D. None of the Above

132. Which of the following is a major cause of odors in ponds?
A. Sulfate reduction C. Acid-forming bacteria
B. Methane fermentation D. None of the Above

Nutrient Constituents in Wastewater and Measurement Methods
Nitrogen
133. 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

134. 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

135. 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:
136. Nitrogen components in wastewater are typically reported on an "_____" basis?
A. As Nitrite C. As nitrogen
B. As Nitrate D. None of the Above

137. Wastewater treatment plants are designed for nitrification and denitrification and these can remove 80 to 95 percent of _____, but the removal of organic nitrogen is typically much less efficient.
A. TKN C. Aliphatic N compounds
B. Inorganic nitrogen D. None of the Above

138. According to the text, domestic wastewater organic nitrogen may be present in particulate, colloidal or dissolved forms and consist of proteins, amino acids, _____, refractory natural compounds in drinking water.
A. VFAs C. Aliphatic N compounds
B. Nitrites D. None of the Above

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

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

141. Other forms of _____ may be more persistent in wastewater treatment processes.
A. TKN C. Dissolved, biodegradable compounds
B. Organic nitrogen D. None of the Above

Filamentous Bacteria
142. 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

143. 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

Facultative Bacteria
144. 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
145. A typical use for _____ would be in a septic tank.
A. Aerobic bacteria C. Facultative bacteria
B. Anaerobic bacteria D. None of the Above

146. 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

147. 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

148. In order to remove a given amount of organic material in an anaerobic treatment system, the organic material must be exposed to a _____ and/or detained for a much longer period of time.
A. Anaerobic action C. Significantly higher quantity of bacteria
B. Absence of free oxygen D. None of the Above

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

Fecal Coliform Bacteria
150. 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

151. 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

Protozoans and Metazoans
152. 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 C. Protozoans and metazoans
B. Macroinvertebrates D. None of the Above

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

Dispersed Growth
154. 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 C. Bulking sludge
B. Dispersed growth D. None of the Above

Paramecium sp.

155. 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) C. Euglypha
B. Paramecium D. None of the Above

156. 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 C. Shelled amoeba(s)
B. Euglypha D. None of the Above

Activated Sludge Bugs

157. In the Activated Sludge process, the _____are also called waste activated sludge.

A. Organisms C. Mixed liquor
B. Settled bugs D. None of the Above

158. The Bacteria have several interesting properties--their “fat reserve” is stored on the outside of their body and this strange feature?

A. Fur C. No Mouth
B. Feet D. None of the Above

159. Once the bacteria have “contacted” their food, they start the digestion process. A chemical Enzyme is sent out through the cell wall to break up the_____.

A. Mixed liquor C. Total Dissolved Solids
B. Organic compounds D. None of the Above

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

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

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

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

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

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

Vorticella sp.

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

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

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

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

Euglypha sp.

165. Which of the following bugs spines may be single or in groups of two or three?
A. Shelled amoeba(s) C. Vorticella
B. Euglypha D. None of the Above

166. The shell of this bug is often transparent, allowing the hyaline (watery) body to be seen inside the shell.
A. Euglypha C. Euchlanis
B. Shelled amoeba(s) D. None of the Above

Euchlanis sp.

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

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

168. Which of the following settles too slowly and is not compactable, and caused by the predominance of filamentous organisms?
A. Settling sludge C. Bulking sludge
B. Organic material D. None of the Above

169. Which of the following terms' content in clarified effluent, which may be due to too high or too low solids retention time and to growth of filamentous microorganisms?
A. Organic material C. Biomass health and effluent quality
B. High solids D. None of the Above

170. Which of the following wastewater treatment related terms occurs when sludge that normally settles rises back to the surface after having settled?
A. Denitrification C. Rising sludge
B. Bulking sludge D. None of the Above

Filamentous Organisms

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

Filamentous Bacteria Identification

172. The foam from Nocardia amarae is usually a _____ unless algae are entrapped in it, in which case it appears green and brown.
A. Viscous brown color C. Gram-positive, chemoautotrophic, filamentous
B. Staining gram-positive D. None of the Above

Microthrix parvicella

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

Sphaeroliticus natans

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

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

Filamentous Bacteria

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

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

Laboratory Analysis/ Process Control Section

pH Testing Section

176. When an atom loses _____and thus has more protons than electrons, the atom is a positively-charged ion or cation.

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

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

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

178. Since pH is a logarithmic scale, a difference of one pH unit is equivalent to _____ difference in hydrogen ion concentration

A. 1 C. 10
B. .1 D. None of the Above

Dissolved Oxygen Testing Section

179. 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

180. 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

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

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

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

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

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

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

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

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

Total Solids
187. Which of the following includes both total suspended solids, the portion of total solids retained by a filter and total dissolved solids?
A. Total Solids C. Corrosiveness
B. TDS D. Alkalinity

188. Which of the following can be measured by evaporating a water sample in a weighed dish, and then drying the residue in an oven at 103 to 105° C?
A. Total Solids C. Total Suspended solids
B. TDS D. Alkalinity

189. Which of the following refers to matter suspended or dissolved in water or wastewater, and is related to both specific conductance and turbidity?
A. Total Solids C. Corrosiveness
B. TDS D. Alkalinity

190. Which of the following are the term used for material left in a container after evaporation and drying of a water sample?
A. Total Solids C. Total Suspended solids
B. TDS D. Alkalinity

Total Suspended Solids (TSS)
191. Which of the following can also cause an increase in surface water temperature, because the suspended particles absorb heat from sunlight?
A. Total Solids C. Total Suspended solids
B. High TSS D. Alkalinity

192. Which of the following can fill in spaces between rocks that could have been used by aquatic organisms for homes?
A. Oxygen C. Settling sediments
B. High TSS D. Suspended sediment

193. Which of the following can include a wide variety of material, such as silt, decaying plant and animal matter, industrial wastes, and sewage?
A. Total Solids C. Total Suspended solids
B. TDS D. Alkalinity

194. Which of the following can block light from reaching submerged vegetation?
A. Oxygen C. Settling sediments
B. High TSS D. Suspended sediment

Settleometer Test
195. 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

196. 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

197. 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

198. 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

199. Do not allow the sample to set for more than a few minutes before the settling test is performed. Determine the _____in milligrams per liter on a portion of this sample.
A. MLSS concentration C. Nitrates
B. The solids D. None of the Above

200. Solids that settle too quickly may be an indication of _____that will probably leave straggler floc in the effluent, while solids that settle too slowly or do not compact well may be washed out of the clarifier during times of high hydraulic load.
A. Settled sludge C. Sludge volume
B. An old sludge D. None of the Above