Registration form

TERTIARY TREATMENT TRAINING COURSE $200.00

48 HOUR RUSH ORDER PROCESSING FEE ADDITIONAL $50.00

Start and finish dates: ____
You will have 90 days from this date in order to complete this course

Name________________________________**Signature**_________________________
I have read and understood the disclaimer notice on page 2. Digitally sign XXX

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Phone:
Home (____)__________________ **Work (____)**________________________

Operator ID #______________________________**Exp. Date**________________

Class/Grade__________________________________

Please circle/check which certification you are applying the course CEU's.

Collection___ Wastewater Treatment ___ Pretreatment____ Other ____________________

Your certificate will be mailed to you in about two weeks unless you pay for the rush service.

Technical Learning College PO Box 420, Payson AZ 85547-0420
Primary Fax (928) 272-0747 Backup Fax (928) 468-0675
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Visa or MasterCard #______________________________________**Exp. Date**__________

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

DISCLAIMER NOTICE

I understand that it is my responsibility to ensure that this CEU course is either approved or accepted in my State for CEU credit. I understand State laws and rules change on a frequent basis and I believe this course is currently accepted in my State for CEU or contact hour credit, if it is not, I will not hold Technical Learning College responsible. I also understand that this type of study program deals with dangerous conditions and that I will not hold Technical Learning College, Technical Learning Consultants, Inc. (TLC) liable for any errors or omissions or advice contained in this CEU education training course or for any violation or injury caused by this CEU education training course material. I will call or contact TLC if I need help or assistance and double-check to ensure my registration page and assignment has been received and graded.

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

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

State Approval Listing URL…

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You can obtain a printed version of the course manual from TLC for an additional $79.95 plus shipping charges.

AFFIDAVIT OF EXAM COMPLETION

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

Grading Information

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

For security purposes, please fax or e-mail a copy of your driver's license and always call us to confirm we've received your assignment and to confirm your identity.

Thank you…

Tertiary Treatment Answer Key

Name______________________________

Phone #________________________________

Multiple Choice. Pick only one answer per question. Select answer according to text, exactly as in text. Circle, Mark off, underline or Bold the answer.

1.	A B C D E F	38.	A B C D E F	75.	A B C D E F
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396. A B C D E F	399. A B C D E F	

Please fax or e-mail the answer key to TLC
Western Campus Fax (928) 272-0747.

Rush Grading Service
If you need this assignment graded and the results mailed to you within a 48-hour period, prepare to pay an additional rush service handling fee of $50.00. This fee may not cover postage costs. If you need this service, simply write RUSH on the top of your Registration Form. We will place you in the front of the grading and processing line.

For security purposes, please fax or e-mail a copy of your driver's license and always call us to confirm we've received your assignment and to confirm your identity. Thank you…

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

TERTIARY TREATMENT TRAINING CEU COURSE
CUSTOMER SERVICE RESPONSE CARD

NAME: _________________________

E-MAIL_________________________________PHONE_____________________

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

1. Please rate the difficulty of your course.
   Very Easy 0 1 2 3 4 5 Very Difficult

2. Please rate the difficulty of the testing process.
   Very Easy 0 1 2 3 4 5 Very Difficult

3. Please rate the subject matter on the exam to your actual field or work.
   Very Similar 0 1 2 3 4 5 Very Different

4. How did you hear about this Course? ____________________________________

5. What would you do to improve the Course?

How about the price of the course?

Poor_____ Fair ____ Average ____ Good____ Great_____

How was your customer service?

Poor___ Fair ____ Average ____ Good _____ Great_____

Any other concerns or comments.

Tertiary Treatment Training Course Assignment

Your assignment is to correctly answer the following questions about the characteristic of the wastewater treatment system, nutrients and nutrient removal, filtration, microbes, bugs and the activated sludge process.

You will have 90 days in order to successfully complete this assignment with a score of 70% or better. If you need any assistance, please contact TLC's Student Services. Once you are finished, please, e-mail or fax or e-mail your answer sheet along with your registration form.

Please use the Answer Key and Registration form. Select the exact answer from text.

Coagulation-Sedimentation Process

1. Alum, lime, or iron salts are chemicals added to the wastewater to remove phosphorus. With these chemicals, the smaller particles '___________' or clump together into large masses.
A. Carbon adsorption D. Municipal wastewater
B. Floc E. Chemical sludge
C. Larger masses of particles F. None of the Above

2. The larger masses of particles will settle faster when the effluent reaches the next step the sedimentation tank. This process can reduce the concentration of ________________by more than 95 percent.
A. Carbon adsorption D. Phosphate
B. Floc E. Chemical sludge
C. Larger masses of particles F. None of the Above

3. Although used for years in the treatment of industrial wastes and in water treatment, ______ is considered an advanced process because it is not routinely applied to the treatment of municipal wastewater.
A. Carbon adsorption D. Municipal wastewater
B. Coagulation-sedimentation E. Chemical sludge
C. Larger masses of particles F. None of the Above

4. A process known as __________________is used to increase the removal of solids from effluent after primary and secondary treatment.
A. Carbon adsorption D. Chemical coagulation-sedimentation
B. Floc E. Chemical sludge
C. Larger masses of particles F. None of the Above

5. Solids heavier than water settle out of wastewater by________________. With the addition of specific chemicals, solids can become heavier than water and will settle.
A. Carbon adsorption D. Municipal wastewater
B. Gravity E. Chemical sludge
C. Larger masses of particles F. None of the Above

6. In some cases, the process is used as a necessary pretreatment step for other advanced techniques. This process produces a _______________, and the cost of disposing of this material can be significant.
A. Carbon adsorption D. Municipal wastewater
B. Floc E. Chemical sludge
C. Larger masses of particles F. None of the Above

Carbon Adsorption

7. Carbon adsorption technology can remove organic materials from wastewater that resist removal by biological treatment. These resistant, trace _________________can contribute to taste and odor problems in water, taint fish flesh, and cause foaming and fish kills.

A. Carbon adsorption D. Municipal wastewater
B. Floc E. Chemical sludge
C. Organic substances F. None of the Above

8. Carbon adsorption consists of passing the wastewater effluent through a bed or canister of activated carbon granules or powder which remove more than 98 percent of the trace ________.

A. Carbon adsorption D. Organic substances
B. Floc E. Chemical sludge
C. Larger masses of particles F. None of the Above

9. The substances adhere to the _________________and are removed from the water. To help reduce the cost of the procedure, the carbon granules can be cleaned by heating and used again.

A. Carbon surface D. Municipal wastewater
B. Floc E. Chemical sludge
C. Larger masses of particles F. None of the Above

The Use or Disposal of Wastewater Residuals and Biosolids

10. When pollutants are removed from water, there is always something left over. It may be rags and sticks caught on the screens at the beginning of primary treatment. It may be the solids that settle to the bottom of____________________.

A. Sedimentation tanks D. Municipal wastewater
B. Biosolids E. Undigested sludge solids
C. Stabilization F. None of the Above

11. The utilization and disposal of the ___________________is addressed by the CWA, Resource Conservation and Recovery Act (RCRA), and other federal laws.

A. Sewage sludge D. Municipal wastewater
B. Biosolids E. Undigested sludge solids
C. Residual process solids F. None of the Above

12. These Federal laws re-enforce the need to employ environmentally sound residuals management techniques and to beneficially use _____________ whenever possible.

A. Sewage sludge D. Municipal wastewater
B. Biosolids E. Undigested sludge solids
C. Stabilization F. None of the Above

Processed Wastewater Solids

13. Biosolids are processed wastewater solids ("_____________") that meet rigorous standards allowing safe reuse for beneficial purposes.

A. Sewage sludge D. Municipal wastewater
B. Biosolids E. Undigested sludge solids
C. Stabilization F. None of the Above

14. Currently, more than half of the _______________ produced by municipal wastewater treatment systems are applied to land as a soil conditioner or fertilizer and the remaining solids are incinerated or landfilled.

A. Sewage sludge D. Municipal wastewater
B. Biosolids E. Undigested sludge solids
C. Stabilization F. None of the Above

Biosolids Stabilization

15. Prior to utilization or disposal, _____________ are stabilized to control odors and reduce the number of disease-causing organisms.

A. Sewage sludge D. Municipal wastewater
B. Biosolids E. Undigested sludge solids
C. Stabilization F. None of the Above

16. Sewage solids, or sludge, when separated from the wastewater, still contain around 98 percent water. They are usually thickened and may be dewatered to reduce the volume to be transported for final processing,___________________.

A. Sewage sludge D. Disposal, or beneficial use
B. Biosolids E. Undigested sludge solids
C. Stabilization F. None of the Above

Dewatering Processes

17. Dewatering processes include drying beds, _________________, plate and frame presses, and centrifuges.

A. Sewage sludge D. Belt filter presses
B. Biosolids E. Undigested sludge solids
C. Stabilization F. None of the Above

18. To improve dewatering effectiveness, the solids can be pretreated with chemicals such as lime, ferric chloride, or polymers to produce ________________which are easier to remove.

A. Larger particles D. Municipal wastewater
B. Biosolids E. Undigested sludge solids
C. Stabilization F. None of the Above

Digestion

19. Digestion is a form of stabilization where the volatile material in the _____________can decompose naturally and the potential for odor production is reduced.

A. Sewage sludge D. Wastewater solids
B. Biosolids E. Undigested sludge solids
C. Stabilization F. None of the Above

20. Digestion without air in an enclosed tank (anaerobic solids digestion) has the added benefit of producing _________________which can be recovered and used as a source of energy.

A. Sewage sludge D. Municipal wastewater
B. Biosolids E. Undigested sludge solids
C. Methane gas F. None of the Above

21. _________________ may also be accomplished by composting, heat treatments, drying or the addition of lime or other alkaline materials. After stabilization, the biosolids can be safely spread on land.

A. Sewage sludge D. Municipal wastewater
B. Biosolids E. Undigested sludge solids
C. Stabilization of solids F. None of the Above

Land Application

22. In many areas, _____________ are marketed to farmers as fertilizer. Federal regulation (40 CFR Part 503) defines minimum requirements for such land application practices, including contaminant limits, field management practices, treatment requirements, monitoring, recordkeeping, and reporting requirements.

A. Sewage sludge D. Municipal wastewater
B. Biosolids E. Undigested sludge solids
C. Stabilization F. None of the Above

23. Properly treated and applied ______________ are a good source of organic matter for improving soil structure and help supply nitrogen, phosphorus, and micronutrients that are required by plants.
A. Sewage sludge D. Municipal wastewater
B. Biosolids E. Undigested sludge solids
C. Stabilization F. None of the Above

24. _____________have also been used successfully for many years as a soil conditioner and fertilizer, and for restoring and revegetating areas with poor soils due to construction activities, strip mining or other practices.
A. Sewage sludge D. Municipal wastewater
B. Biosolids E. Undigested sludge solids
C. Stabilization F. None of the Above

25. Under this ______________ management approach, treated solids in semi liquid or dewatered form are transported to the soil treatment areas.
A. Sewage sludge D. Municipal wastewater
B. Biosolids E. Undigested sludge solids
C. Stabilization F. None of the Above

26. The slurry or dewatered biosolids, containing nutrients and_________________, is spread over the land to give nature a hand in returning grass, trees, and flowers to barren land.
A. Sewage sludge D. Municipal wastewater
B. Biosolids E. Undigested sludge solids
C. Stabilized organic matter F. None of the Above

27. Restoration of the countryside also helps control the flow of acid drainage from mines that endangers fish and other _________________and contaminates the water with acid, salts, and excessive quantities of metals.
A. Sewage sludge D. Municipal wastewater
B. Biosolids E. Aquatic life
C. Stabilization F. None of the Above

Beneficial Use Products from Biosolids

28. Effective pretreatment of industrial wastes prevents excessive levels of unwanted constituents, such as ________________(i.e. cadmium, mercury, and lead) and persistent organic compounds from contaminating the residuals of wastewater treatment and limiting the potential for beneficial use.
A. Sewage sludge D. Treating wastewater
B. Biosolids E. Heavy metals
C. Stabilization F. None of the Above

29. Effective stabilization of wastewater residuals and their conversion to biosolid products can be costly. Some cities have produced fertilizers from ______________ which are sold to help pay part of the cost of treating wastewater.
A. Sewage sludge D. Treating wastewater
B. Biosolids E. Effective pretreatment
C. Stabilization F. None of the Above

30. Some municipalities use composted, heat dried, or lime _________________biosolid products on parks and other public areas.
A. Sewage sludge D. Treating wastewater
B. Biosolids E. Effective pretreatment
C. Stabilized F. None of the Above

31. Heat dried ______________ pellets have been produced and used extensively as a fertilizer product for lawn care, turf production, citrus groves, and vegetable production for many years.
A. Sewage sludge D. Municipal wastewater
B. Biosolids E. Undigested sludge solids
C. Stabilization F. None of the Above

32. Composting of ______________ is also a well-established approach to solids management that has been adopted by a number of communities.
A. Sewage sludge D. Municipal wastewater
B. Biosolids E. Undigested sludge solids
C. Stabilization F. None of the Above

33. The composted ______________has shown particular promise for use in the production of soil additives for revegetation of topsoil depleted areas, and as a potting soil amendment.
A. Sewage sludge D. Municipal wastewater
B. Biosolids E. Peat-like product
C. Stabilization F. None of the Above

Decentralized (Onsite and Cluster) Systems

34. A decentralized wastewater system treats sewage from homes and businesses that are not connected to a__________________. Decentralized treatment systems include onsite systems and cluster systems.
A. Sewage sludge D. Centralized wastewater treatment plant
B. Biosolids E. Effective pretreatment
C. Stabilization F. None of the Above

35. An onsite system is a wastewater system relying on natural processes, although sometimes containing mechanical components, to collect, treat, disperse or _______________from a single dwelling or building. A septic tank and soil adsorption field is an example of an onsite system.
A. Sewage sludge D. Reclaim wastewater
B. Biosolids E. Effective pretreatment
C. Stabilization F. None of the Above

36. A wastewater collection and treatment system under some form of common ownership that collects wastewater from two or more dwellings or buildings and conveys it to a treatment and ________________located on a suitable site near the dwellings or buildings is a cluster system.
A. Dispersal system D. Treating wastewater
B. Biosolids E. Effective pretreatment
C. Stabilization F. None of the Above

37. Decentralized systems include those using alternative treatment technologies like media filters, constructed wetland systems, aerobic treatment units, and a variety of soil ___________.
A. Sewage sludge D. Treating wastewater
B. Biosolids E. Effective pretreatment
C. Dispersal systems F. None of the Above

38. ______________include pressure systems such as low pressure pipe and drip dispersal systems. These systems treat and disperse relatively small volumes of wastewater, and are generally are found in rural and suburban areas.
A. Septic tank(s) D. Soil dispersal systems
B. Septage E. Aerobic treatment units
C. Stabilization F. None of the Above

39. While septic tanks and soil absorption systems have significant limitations, decentralized systems can _________________and public health from groundwater and surface water contamination if managed properly (i.e. properly sited, sized, designed, installed, operated, and maintained).

A. Septic tank(s)
B. Septage
C. Stabilization
D. Effectively protect water quality
E. Aerobic treatment units
F. None of the Above

40. ________________in groundwater that exceed the drinking water standards can cause health problems.

A. Septic tank(s)
B. Septage
C. Nitrate concentrations
D. Treated effluent
E. Aerobic treatment units
F. None of the Above

Onsite Treatment

41. Onsite wastewater systems contain three components: a treatment unit which treats water prior to dispersal into the environment; a soil dispersal component which assures that treated water is released into the environment at a rate which can be assimilated; and a management system which assures _________________of the complete system.

A. Septic tank(s)
B. Proper long term operation
C. Stabilization
D. Treated effluent
E. Aerobic treatment units
F. None of the Above

42. ________________of the treated effluent may be provided prior to dispersal. A typical onsite system consists of a septic tank followed by an effluent distribution system.

A. Septic tank(s)
B. Septage
C. Stabilization
D. Treated effluent
E. Disinfection
F. None of the Above

Conventional Septic Tanks

43. A septic tank is a tank buried in the ground used to _______________without the presence of oxygen (anaerobic).

A. Septic tank(s)
B. Septage
C. Treat sewage
D. Treated effluent
E. Aerobic treatment units
F. None of the Above

44. The sewage flows from the plumbing in a home or small business establishment into the first of two chambers, where_____________.

A. Septic tank(s)
B. Septage
C. Solids settle out
D. Treated effluent
E. Aerobic treatment units
F. None of the Above

45. The liquid then flows into the second chamber. ______________in the sewage break down the organic matter, allowing cleaner water to flow out of the second chamber.

A. Septic tank(s)
B. Septage
C. Anaerobic bacteria
D. Treated effluent
E. Aerobic treatment units
F. None of the Above

46. The liquid typically discharges through a subsurface distribution system. Periodically, the ________________in the bottom of the tank, referred to as septage, must be removed and disposed of properly.

A. Septic tank(s)
B. Solid matter
C. Stabilization
D. Treated effluent
E. Aerobic treatment units
F. None of the Above

Aerobic Treatment Units

47. Aerobic treatment units are also used to provide_________________. They are similar to septic tanks, except that air is introduced and mixed with the wastewater inside the tank.

A. Septic tank(s) D. Onsite wastewater treatment
B. Septage E. Aerobic treatment units
C. Stabilization F. None of the Above

48. Aerobic (requiring oxygen) bacteria consume the organic matter in the sewage. As with the typical septic system, the effluent discharge from an aerobic system is typically released through a ______________distribution system or may be disinfected and discharged directly to surface water.

A. Septic tank(s) D. Treated effluent
B. Sub-surface E. Aerobic treatment units
C. Stabilization F. None of the Above

49. __________________also require the removal and proper disposal of solids that accumulate in the tank.

A. Septic tank(s) D. Treated effluent
B. Septage E. Aerobic treatment units
C. Stabilization F. None of the Above

Media Filters

50. Media filters are used to provide further treatment of septic tank effluent, and provide high_________________. They can be designed to pass the effluent once or multiple times through the media bed. Media, such as sand, acts as a filter.

A. Septic tank(s) D. Levels of nitrification
B. Media E. A mound system
C. Wastewater F. None of the Above

51. The ____________ is placed two to three feet deep above a liner of impermeable material such as plastic or concrete.

A. Septic tank(s) D. An absorption field
B. Media E. A mound system
C. Wastewater F. None of the Above

52. Septic tank effluent is applied to the filter surface in intermittent doses and is further treated as it slowly trickles through the ____________. In most media filters, wastewater is collected in an underdrain then either pumped back to the filter bed or to other types of treatment.

A. Septic tank(s) D. An absorption field
B. Media E. A mound system
C. Wastewater F. None of the Above

Dispersal Approaches

53. The most common alternative dispersal systems include low-pressure pipe, __________, drip disposal, and evapotranspiration beds.

A. Septic tank(s) D. An absorption field
B. Media E. Mounds
C. Wastewater F. None of the Above

Absorption Field

54. When soil conditions permit, the most common method to disperse septic tank or aerobic system effluent is _______________ consisting of a series of perforated parallel pipes laid in trenches on gravel or crushed stone or as a direct discharge to the soil through trenches.

A. Septic tank(s) D. An absorption field
B. Media E. A mound system
C. Wastewater F. None of the Above

55. Typically, effluent flows into the absorption field from a _______________which maintains an even flow of effluent to the absorption field. From there, the effluent drains through the stone and into the soil which provides further treatment.
A. Septic tank(s) D. An absorption field
B. Distribution box E. A mound system
C. Wastewater F. None of the Above

56. Traditional ________________include treatment units followed by a drainfield or absorption field.
A. Septic tank(s) D. An absorption field
B. Onsite systems E. A mound system
C. Wastewater F. None of the Above

57. Wastewater from the treatment unit is dispersed through a suitable soil layer where it receives additional treatment by the soil microorganisms and filtering properties of the soil. If the soil is unsuitable for the installation of a soil absorption field, _______________can be used to further treat or distribute the treated effluent.
A. Septic tank(s) D. An absorption field
B. Media E. Alternative methods
C. Wastewater F. None of the Above

Biological Criteria
58. A water body in its natural condition is free from the harmful effects of pollution, habitat loss, and other negative stressors. It is characterized by a particular _____________and abundance of organisms.
A. Food chain D. Mixed, complex and interrelated
B. Biological diversity E. Stabilization of organic wastes
C. Water bodies or Various bodies of water F. None of the Above

59. This biological integrity--or natural structure and function of aquatic life--can be dramatically different in various types of water bodies in different parts of the country. Because of this, the EPA is developing methodologies that states can use to assess the ___________of their waters and, in so doing, set protective water quality standards.
A. Food chain D. Mixed, complex and interrelated
B. Sediment-dwelling organisms E. Biological integrity
C. Water bodies or Various bodies of water F. None of the Above

60. These methodologies will describe scientific methods for determining a particular aquatic community's health and for maintaining ____________in various bodies of water.
A. Optimal conditions D. Mixed, complex and interrelated
B. Sediment-dwelling organisms E. Stabilization of organic wastes
C. Water bodies or Various bodies of water F. None of the Above

Summary
61. The goal of all biological wastewater treatment systems is to remove the ____________and the dissolved organic load from the effluents by using microbial populations.
A. Microbial populations D. Mixed, complex and interrelated
B. Non-settling solids E. Attached growth processes
C. Facultative micro-organisms F. None of the Above

62. ________________are generally part of secondary treatment systems.
A. Microbial populations D. Mixed, complex and interrelated
B. Non-biodegradable portion E. Attached growth processes
C. Biological treatments F. None of the Above

63. The microorganisms used are responsible for the _______________of the organic matter and the stabilization of organic wastes.
A. Degradation D. Mixed, complex and interrelated
B. Non-biodegradable portion E. Attached growth processes
C. Facultative micro-organisms F. None of the Above

64. With regard to the way in which they utilize oxygen, they can be classified into aerobic (require oxygen for their metabolism), anaerobic (grow in absence of oxygen) and facultative (can proliferate either in absence or presence of oxygen although using______________).
A. Microbial populations D. Mixed, complex and interrelated
B. Non-biodegradable portion E. Different metabolic processes
C. Facultative micro-organisms F. None of the Above

65. Most of the micro-organisms present in wastewater treatment systems use the organic content of the wastewater as an energy source to grow, and are thus classified as heterotrophes from a__________________.
A. Microbial populations D. Nutritional point of view
B. Non-biodegradable portion E. Attached growth processes
C. Facultative micro-organisms F. None of the Above

66. The population active in a biological wastewater treatment _____________.
A. Microbial populations D. Mixed, complex and interrelated
B. Non-biodegradable portion E. Attached growth processes
C. Facultative micro-organisms F. None of the Above

67. In a well-functioning system, __________________are usually present and are useful in consuming dispersed bacteria or non-settling particles. More extensive description and treatment of the microbiology of wastewater treatment systems are given elsewhere.
A. Microbial populations D. Mixed, complex and interrelated
B. Protozoas and rotifers E. Attached growth processes
C. Facultative micro-organisms F. None of the Above

68. The organic load present is incorporated in part as biomass by the microbial populations, and almost all the rest is liberated as gas (carbon dioxide (CO_2) if the treatment is aerobic, or carbon dioxide plus methane (CH_4) if the process is anaerobic) and water. In fisheries wastewaters the ______________ is very low.
A. Microbial populations D. Mixed, complex and interrelated
B. Non-biodegradable portion E. Attached growth processes
C. Facultative micro-organisms F. None of the Above

69. Unless the cell mass formed during the ___________is removed from the wastewater, the treatment is largely incomplete, because the biomass itself will appear as organic load in the effluent and the only pollution reduction accomplished is that fraction liberated as gases.
A. Microbial populations D. Mixed, complex and interrelated
B. Non-biodegradable portion E. Attached growth processes
C. Biological treatment F. None of the Above

70. The biological treatment processes used for wastewater treatment are broadly classified as aerobic in which aerobic and __________________ predominate or anaerobic which use anaerobic micro-organism.
A. Microbial populations D. Mixed, complex and interrelated
B. Non-biodegradable portion E. Attached growth processes
C. Facultative micro-organisms F. None of the Above

71. If the microorganisms or Bugs are suspended in the wastewater during biological operation, the operations are "_______________", while the micro-organisms that are attached to a surface over which they grow are called "attached growth processes".
A. Microbial populations
B. Non-biodegradable portion
C. Facultative micro-organisms
D. Mixed, complex and interrelated
E. Called suspended growth processes
F. None of the Above

F/M and MCRT
72. The following are some general statements about _________________assuming that the environmental conditions are properly controlled.
A. Rotifers
B. Stalked ciliates
C. Gliding ciliates
D. F/M and MCRT
E. New sludge
F. None of the Above

73. The optimum operating point of either helps obtain the_________________.
A. Rotifers
B. Stalked ciliates
C. Gliding ciliates
D. Best effluent and sludge quality
E. Desired effluent concentration
F. None of the Above

74. Both provide a means for maintaining the ____________________.
A. Rotifers
B. Stalked ciliates
C. Gliding ciliates
D. Best effluent and sludge quality
E. New sludge
F. None of the Above

75. Both techniques attempt to regulate rate of growth, metabolism, and stabilization________.
A. Rotifers
B. Stalked ciliates
C. Gliding ciliates
D. Best effluent and sludge quality
E. New sludge
F. None of the Above

76. Both techniques indicate the solids level needed to _______________and attain sludge quality.
A. Rotifers
B. Stalked ciliates
C. Gliding ciliates
D. Stabilize the food
E. New sludge
F. None of the Above

77. The operating control point is that point when the best effluent and ______________is obtained for the existing conditions.
A. Rotifers
B. Stalked ciliates
C. Gliding ciliates
D. Sludge quality
E. New sludge
F. None of the Above

Microorganisms in Lagoons
78. Swimming and ________________ engulf bacteria or other prey.
A. Rotifers
B. Stalked ciliates
C. Gliding ciliates
D. Best effluent and sludge quality
E. New sludge
F. None of the Above

79. Stalked ciliates attach to the biomass and ______________into their gullets, while crawlers break bacteria loose from the floc surface.
A. Vortex suspended bacteria
B. Stalked ciliates
C. Gliding ciliates
D. Best effluent and sludge quality
E. New sludge
F. None of the Above

80. Predators feed mostly on stalked and__________________. The omnivores, such as most rotifers, eat whatever is readily available, while the worms feed on the floc or prey on larger organisms. Microorganisms are directly affected by their treatment environment.

A. Rotifers
B. Swimming ciliates
C. Gliding ciliates
D. Best effluent and sludge quality
E. New sludge
F. None of the Above

81. Changes in food, dissolved oxygen, temperature, pH, ___________, sludge age, presence of toxins, and other factors create a dynamic environment for the treatment organisms.

A. Rotifers
B. Stalked ciliates
C. Gliding ciliates
D. Best effluent and sludge quality
E. Total dissolved solids
F. None of the Above

82. Food (organic loading) regulates_________________, diversity, and species when other factors are not limiting. The relative abundance and occurrence of organisms at different loadings can reveal why some organisms are present in large numbers while others are absent.

A. Degrade BOD
B. Oxidize BOD
C. High organic loading
D. Microorganism numbers
E. Wide range in environmental tolerance
F. None of the Above

Aerobic Bacteria

83. The aerobic bacteria that occur are similar to those found in other treatment processes such as activated sludge. Three functional groups occur:_____________, single bacteria; floc-forming bacteria; and filamentous bacteria. All function similarly to oxidize organic carbon (BOD) to produce CO_2 and new bacteria (new sludge).

A. Degrade BOD
B. Freely dispersed
C. High organic loading
D. Regulates microorganism numbers
E. Wide range in environmental tolerance
F. None of the Above

84. Many bacterial species that degrade wastes grow as single bacteria dispersed in the wastewater. Although these readily ______________, they do not settle and hence often leave the system in the effluent as solids (TSS).

A. Degrade BOD
B. Oxidize BOD
C. High organic loading
D. Regulates microorganism numbers
E. Wide range in environmental tolerance
F. None of the Above

Nitrification

85. It was once thought that only two bacteria were involved in nitrification: Nitrosomonas europaea, which________________, and Nitrobacter winogradskyi, which oxidizes nitrite to nitrate.

A. Nitrifying bacteria
B. Bacteria oxidize ammonia
C. Reduced biological activity
D. Non-biodegradable fraction
E. Oxidizes ammonia to nitrite
F. None of the Above

86. It is now known that at least 5 genera of bacteria oxidize ammonia and at least three genera of_________________.

A. Nitrifying bacteria
B. Bacteria oxidize ammonia
C. Bacteria oxidize nitrite
D. Non-biodegradable fraction
E. Oxidizes nitrite to nitrate
F. None of the Above

87. Besides oxygen, these nitrifying bacteria require a neutral pH (7-8) and substantial alkalinity (these autotrophs use CO_2 as a carbon source for growth). This indicates that complete ____________would be expected at pond pH values between pH 7.0 and 8.5.

A. Nitrifying bacteria
B. Nitrification
C. Reduced biological activity
D. Non-biodegradable fraction
E. Oxidizes nitrite to nitrate
F. None of the Above

88. Nitrification ceases at pH values above pH 9 and declines markedly at pH values below 7. This results from the growth inhibition of the _________________.

A. Nitrifying bacteria D. Non-biodegradable fraction
B. Bacteria oxidize ammonia E. Oxidizes nitrite to nitrate
C. Reduced biological activity F. None of the Above

89. Nitrification, is not a major pathway for nitrogen removal in lagoons. __________________ exists in low numbers in lagoons. They prefer attached growth systems and/or high MLSS sludge systems.

A. Nitrifying bacteria D. Non-biodegradable fraction
B. Bacteria oxidize ammonia E. Oxidizes nitrite to nitrate
C. Reduced biological activity F. None of the Above

Anaerobic Bacteria

90. Anaerobic, heterotrophic bacteria that commonly occur in lagoons are involved in methane formation (acid-forming and methane bacteria) and in _______________(sulfate reducing bacteria).

A. An anaerobic fermenter D. General anaerobic degraders
B. Sulfate reduction E. Anaerobic methane formation
C. Methane bacteria F. None of the Above

91. ______________ involves three different groups of anaerobic bacteria that function together to convert organic materials to methane via a three-step process.

A. An anaerobic fermenter D. General anaerobic degraders
B. Acid formers E. Anaerobic methane formation
C. Methane bacteria F. None of the Above

92. _______________ - many genera of anaerobic bacteria hydrolyze proteins, fats, and poly saccharides present in wastewater to amino acids, short-chain peptides, fatty acids, glycerol, and mono- and di-saccharides. These have a wide environmental tolerance in pH and temperature.

A. An anaerobic fermenter D. General anaerobic degraders
B. Acid formers E. Anaerobic methane formation
C. Methane bacteria F. None of the Above

Photosynthetic Organisms

93. ________________- this diverse group of bacteria converts products from above under anaerobic conditions to simple alcohols and organic acids such as acetic, propionic, and butyric. These bacteria are hardy and occur over a wide pH and temperature range.

A. An anaerobic fermenter D. General anaerobic degraders
B. Acid-forming bacteria E. Anaerobic methane formation
C. Methane bacteria F. None of the Above

94. ________________- these bacteria convert formic acid, methanol, methylamine, and acetic acid under anaerobic conditions to methane.

A. An anaerobic fermenter D. General anaerobic degraders
B. Acid formers E. Anaerobic methane formation
C. Methane forming bacteria F. None of the Above

Photosynthetic Organisms

95. ________________ are environmentally sensitive and have a narrow pH range of 6.5-7.5 and require temperatures > 14^o C.

A. An anaerobic fermenter D. General anaerobic degraders
B. Acid formers E. Anaerobic methane formation
C. Methane bacteria F. None of the Above

96. Note that the products of the _______________ (principally acetic acid) become the substrate for the methane producers.
A. An anaerobic fermenter D. General anaerobic degraders
B. Acid formers E. Anaerobic methane formation
C. Methane bacteria F. None of the Above

97. 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 called a "___________________".
A. An anaerobic fermenter D. General anaerobic degraders
B. Acid formers E. Stuck digester
C. Methane bacteria F. None of the Above

98. Methane fermentation ceases at cold temperature, probably not occurring in most lagoons in the wintertime in cold climates. A number of ________________(14 genera reported to date) called sulfate reducing bacteria can use sulfate as an electron acceptor, reducing sulfate to hydrogen sulfide.
A. Anaerobic sulfur bacteria D. Anaerobes or microaerophilic
B. Photosynthetic bacteria E. Anaerobic bacteria
C. Anaerobic bacteria F. None of the Above

99. This occurs when BOD and sulfate are present and oxygen is absent. ________________is a major cause of odors in ponds.
A. Sulfate reduction D. Anaerobes or microaerophilic
B. Photosynthetic bacteria E. Anaerobic conditions
C. Anaerobic bacteria F. None of the Above

100. Anaerobic, _________ occur in all lagoons and are the predominant photo-synthetic organisms in anaerobic lagoons.
A. Anaerobic sulfur bacteria D. Anaerobes or microaerophilic
B. Photosynthetic bacteria E. Anaerobic conditions
C. Anaerobic bacteria F. None of the Above

101. The ______________, generally grouped into the red and green sulfur bacteria and represented by about 28 genera, oxidize reduced sulfur compounds (H2S) using light energy to produce sulfur and sulfate,
A. Anaerobic sulfur bacteria D. Anaerobes or microaerophilic
B. Photosynthetic bacteria E. Anaerobic conditions
C. Anaerobic bacteria F. None of the Above

102. H2S is used in place of H2O as used by algae and green plants, producing S04- instead of O2. All are either strict anaerobes or_________________.
A. Anaerobic sulfur bacteria D. Microaerophilic
B. Photosynthetic bacteria E. Anaerobic conditions
C. Anaerobic bacteria F. None of the Above

103. Most common are Chromatium, Thiocystis, and Thiopedia, which can grow in profusion and give a lagoon a pink or red color. Finding them is most often an indication of organic overloading and _________________ in an intended aerobic system.
A. Anaerobic sulfur bacteria D. Anaerobes or microaerophilic
B. Photosynthetic bacteria E. Anaerobic conditions
C. Anaerobic bacteria F. None of the Above

104. Conversion of odorous sulfides to sulfur and sulfate by these sulfur bacteria is a significant odor control mechanism in facultative and____________, and can be desirable.
A. Anaerobic sulfur bacteria D. Anaerobes or microaerophilic
B. Photosynthetic bacteria E. Anaerobic lagoons
C. Anaerobic bacteria F. None of the Above

Treatment Lagoon
105. The ______________ at a treatment lagoon is determined by the various chemical species of alkalinity that are present. The main species present are carbon dioxide (CO2, bicarbonate ion (HCO3), and carbonate ion (CO23).
A. Algae D. Phosphorus
B. pH E. Rotifers and daphnia
C. Bacterial oxidation F. None of the Above

106. Alkalinity and pH can affect which species will be present. High amounts of _________yield a low lagoon pH, while high amounts of CO23 yield a high lagoon pH.
A. Algae D. Phosphorus
B. Alkalinity and pH E. Rotifers and daphnia
C. CO2 F. None of the Above

107. Bacterial growth on _____________releases CO2 which subsequently dissolves in water to yield carbonic acid (H2CO3). This rapidly dissociates to bicarbonate ion, increasing the lagoon alkalinity.
A. Algae D. BOD
B. Alkalinity and pH E. Rotifers and daphnia
C. Bacterial oxidation F. None of the Above

108. ________________ of BOD causes a decrease in lagoon pH due to CO2 release.
A. Algae D. Phosphorus
B. Alkalinity and pH E. Rotifers and daphnia
C. Bacterial oxidation F. None of the Above

109. Algal growth in lagoons has the opposite effect on lagoon pH, raising the pH due to algal use for growth of _______________(CO2 and HCO3).
A. Algae D. Inorganic carbon
B. Alkalinity and pH E. Rotifers and daphnia
C. Bacterial oxidation F. None of the Above

110. Algal growth reduces the lagoon alkalinity which may cause the pH to increase if the lagoon alkalinity (_____________) is low.
A. Algae D. Phosphorus
B. pH buffer capacity E. Rotifers and daphnia
C. Bacterial oxidation F. None of the Above

111. Algae can grow to such an extent in lagoons (a bloom) that they consume all of the CO2 and HCO3 present for photosynthesis, leaving only carbonate (CO23) as the______________.
A. Algae D. Phosphorus
B. pH buffering species E. Rotifers and daphnia
C. Bacterial oxidation F. None of the Above

112. This causes the pH of the lagoon to become alkaline. pH values of 9.5 or greater are common in lagoons during_______________, which can lead to lagoon effluent pH violations (in most states this is pH = 9).
A. Algal blooms D. Phosphorus
B. Alkalinity and pH E. Rotifers and daphnia
C. Bacterial oxidation F. None of the Above

113. It should be noted that an increase in the lagoon pH caused by algal growth can be beneficial. Natural disinfection of _______________ is enhanced at higher pH.
A. Algae D. Pathogens
B. Alkalinity and pH E. Rotifers and daphnia
C. Bacterial oxidation F. None of the Above

114. ____________ removal by natural chemical precipitation is greatly enhanced at pH values greater than pH = 8.5. In addition, ammonia stripping to the atmosphere is enhanced at higher pH values (NH3 is strippable, not NH4+).
A. Algae D. Phosphorus
B. Alkalinity and pH E. Rotifers and daphnia
C. Bacterial oxidation F. None of the Above

Protozoans and Microinvertebrates

115. Many higher life forms (animals) develop in lagoons. These include protozoans and microinvertebrates such as _______________, annelids, chironomids (midge larvae), and mosquito larvae (often termed the zooplankton).
A. Algae D. Phosphorus
B. Alkalinity and pH E. Rotifers and daphnia
C. Bacterial oxidation F. None of the Above

116. These organisms play a role in waste purification by feeding on _____________ and algae and promoting flocculation and settling of particulate material.
A. Algae D. Protozoans
B. Alkalinity and pH E. Rotifers and daphnia
C. Bacteria F. None of the Above

117. __________________ are the most common higher life forms in lagoons with about 250 species identified in lagoons to date.
A. Algae D. Protozoans
B. Alkalinity and pH E. Rotifers and daphnia
C. Bacteria F. None of the Above

118. Rotifers and daphnia are particularly important in controlling algal overgrowth and these often "________________" when algal concentrations are high.
A. Algae D. Protozoans
B. Alkalinity and pH E. Bloom
C. Bacteria F. None of the Above

Activated Sludge Methods

119. We have some wastewater treatment plants that grow the microorganisms (Bugs) in large tanks. To have enough oxygen in the tanks we add _____________by blowing air into the tank full of waste-water and microorganisms.
A. Mass of microbes D. Flocculating characteristics
B. Organic load E. Oxygen
C. Bacteria F. None of the Above

120. The air is bubbled in the water and mixes “the bugs,” food and oxygen together. When we treat wastewater this way, we call it the activated sludge method. With all of this food and air, the _______________ grow and multiply very rapidly.
A. Microbes D. Flocculating characteristics
B. Organic load E. Oxygen demand
C. Bacteria F. None of the Above

121. Pretty soon the population of bugs gets too large and some of them need to be removed to make room for new bugs to grow. We remove the _______________ by sedimentation in the same kind of tanks used for primary treatment.
A. Excess bugs D. Flocculating characteristics
B. Organic load E. Oxygen demand
C. Bacteria F. None of the Above

122. In the tank, the bugs sink to the bottom and we remove them. The settled bugs are also called_______________. The waste sludge is treated separately, and the remaining wastewater is now much cleaner.
A. Mass of microbes D. Waste activated sludge
B. Organic load E. Oxygen demand
C. Bacteria F. None of the Above

123. In fact, after primary and secondary treatment, about 85% or more of all pollutants in the wastewater has been removed and it goes on to Disinfection. These systems originated in England in the early 1900's and earned their name because a sludge (______________) is produced which aerobically degrades and stabilizes the organic load of a wastewater.
A. Mass of microbes D. Flocculating characteristics
B. Organic load E. Oxygen demand
C. Bacteria F. None of the Above

124. For larger systems, especially when high variability is expected, the design involves the use of multiple aeration tanks and multiple settling tanks. The number of units employed depends on the flow of ____________________being generated.
A. Mass of microbes D. Wastewater
B. Organic load E. Oxygen demand
C. Bacteria F. None of the Above

Organic Load
125. 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. Mass of microbes D. Flocculating characteristics
B. Organic load E. Oxygen demand
C. Activated sludge F. None of the Above

126. The mixture then passes to a secondary settling tank where the cells are settled. The treated wastewater is generally discharged after disinfection while the settled ____________is recycled in part to the aeration basin.
A. Mass of microbes D. Flocculating characteristics
B. Biomass E. Oxygen demand
C. Bacteria F. None of the Above

127. The cells must be recycled in order to maintain sufficient biomass to degrade the ________ as quickly as possible.
A. Mass of microbes D. Flocculating characteristics
B. Organic load E. Oxygen demand
C. Bacteria F. None of the Above

128. The amount that is recirculated depends on the need to obtain a high degradation rate and on the need for the __________to flocculate properly so that the secondary settling separates the cells satisfactorily.
A. Mass of microbes D. Flocculating characteristics
B. Organic load E. Oxygen demand
C. Bacteria F. None of the Above

129. As the cells are retained longer in the system, the ________________ of the cells improve since they start to produce extra cellular slime which favors flocculating.
A. Mass of microbes D. Flocculating characteristics
B. Organic load E. Oxygen demand
C. Bacteria F. None of the Above

Common Types
130. The most common types of ___________ are the conventional and the continuous flow stiffed 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.
A. Perturbations D. Activated sludge
B. Oxygen demand E. Suctoria
C. Flow peaks F. None of the Above

131. The _______________ for this arrangement is maximum at the inlet as is the organic load concentration.
A. Perturbations D. Activated sludge systems
B. Oxygen demand E. Suctoria
C. Flow peaks F. None of the Above

132. In the completely mixed process the inflow streams are usually introduced at several points to facilitate the ________________of the mixing; if the mixing is complete, the properties are constant throughout the reactor.
A. Homogeneity D. Activated sludge systems
B. Oxygen demand E. Suctoria
C. Flow peaks F. None of the Above

133. This configuration is inherently more stable to perturbations because mixing causes the dilution of the incoming stream into the tank. In fisheries wastewaters the ___________ that may appear are peaks of concentration of organic load or flow peaks.
A. Perturbations D. Activated sludge systems
B. Oxygen demand E. Suctoria
C. Flow peaks F. None of the Above

134. The flow peaks can be damped in the primary treatment tanks. The conventional configurations would require less reactor volume if _______________could be assured, which usually does not occur.
A. Perturbations D. Activated sludge systems
B. Oxygen demand E. Smooth plug flow
C. Flow peaks F. None of the Above

135. Other versions of ________________ (e.g., extended aeration, contact stabilization, step aeration and pure oxygen processes) are used in other kinds of wastewaters but are not known to be applied to treat fisheries wastewaters.
A. Perturbations D. Activated sludge systems
B. Oxygen demand E. Suctoria
C. Flow peaks F. None of the Above

136. In all ________________, the cells are separated from the liquid and partially returned to the system to have a relatively high concentration of cells that degrade the organic load in a relatively short time.
A. Perturbations D. Activated sludge systems
B. Oxygen demand E. Suctoria
C. Flow peaks F. None of the Above

Bugs or MOs

137. Four groups of bugs do most of the “eating” in the _____________ process. The first group is the bacteria which eat the dissolved organic compounds.
A. Perturbations D. Activated sludge
B. Oxygen demand E. Suctoria
C. Flow peaks F. None of the Above

138. The second and third groups of bugs are microorganisms known as the free-swimming and stalked ciliates. These larger bugs eat the bacteria and are heavy enough to______________.
A. Perturbations D. Activated sludge systems
B. Oxygen demand E. Settle by gravity
C. Flow peaks F. None of the Above

139. The fourth group is a microorganism, known as ____________, which feeds on the larger bugs and assists with settling.
A. Perturbations D. Activated sludge systems
B. Oxygen demand E. Suctoria
C. Flow peaks F. None of the Above

140. The interesting thing about the bacteria that eat the _________________ is they have no mouths.
A. Perturbations D. Dissolved organics
B. Oxygen demand E. Suctoria
C. Flow peaks F. None of the Above

141. The bacteria have an interesting property, their “_______________” are stored on the outside of their bodies. This fat layer is sticky and is what the organics adhere to.
A. Fat reserves D. Activated sludge
B. Contacted E. Hydrolytic enzyme
C. Organic compounds F. None of the Above

142. Once the bacteria have “___________” their food, they start the digestion process.
A. Fat reserves D. Activated sludge
B. Contacted E. Hydrolytic enzyme
C. Organic compounds F. None of the Above

143. A chemical enzyme is sent out through the cell wall to break up the __________.
A. Fat reserves D. Activated sludge
B. Contacted E. Hydrolytic enzyme
C. Organic compounds F. None of the Above

144. This enzyme, known as ______________, breaks the organic molecules into small units which are able to pass through the cell wall of the bacteria.
A. Fat reserves D. Activated sludge
B. Contacted E. Hydrolytic enzyme
C. Organic compounds F. None of the Above

145. In wastewater treatment, this process of using bacteria-eating bugs in the presence of oxygen to reduce the organics in water is called _______________.
A. Fat reserves D. Activated sludge
B. Contacted E. Hydrolytic enzyme
C. Organic compounds F. None of the Above

146. The first step in the process, the contact of the bacteria with the ____________, takes about 20 minutes.
A. Fat reserves D. Activated sludge
B. Contacted E. Hydrolytic enzyme
C. Organic compounds F. None of the Above

147. The second step is the breaking up, ingestion and________, which takes four to 24 hours.
A. Fat reserves D. Digestion processes
B. Contacted E. Hydrolytic enzyme
C. Organic compounds F. None of the Above

148. The fat storage property of the bacteria is also an asset in settling. As the bugs "_____" into each other, the fat on each of them sticks together and causes flocculation of the non-organic solids and biomass.
A. Bump D. Activated sludge
B. Contacted E. Hydrolytic enzyme
C. Organic compounds F. None of the Above

149. From the aeration tank, the wastewater, now called mixed liquor, flows to a secondary clarification basin to allow the _______________to settle out of the water.
A. Fat reserves D. Activated sludge
B. Contacted E. Flocculated biomass of solids
C. Organic compounds F. None of the Above

150. The solids biomass, which is the _____________, contains millions of bacteria and other microorganisms, 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. Fat reserves D. Activated sludge
B. Contacted E. Hydrolytic enzyme
C. Organic compounds F. None of the Above

Paramecium sp.
151. Paramecium is a medium to large size (100-300 -m) swimming ciliate, commonly observed in_______________, sometimes in abundant numbers.
A. Activated sludge D. Stalked ciliate
B. Engulfs suspended bacteria E. Swarmer
C. Filter-feeding ciliate F. None of the Above

152. The body is either foot-shaped or cigar-shaped, and somewhat flexible. Paramecium is uniformly ciliated over the entire body surface with____________.
A. Smooth gliding motion D. Stalked ciliate
B. Engulfs suspended bacteria E. Longer cilia tufts at the rear of the cell
C. Filter-feeding ciliate F. None of the Above

153. Paramecium swims with a _____________. It may also be seen paired up with another Paramecium which makes a good diagnostic key.
A. Smooth gliding motion D. Stalked ciliate
B. Engulfs suspended bacteria E. Swarmer
C. Filter-feeding ciliate F. None of the Above

154. The cell has either one or two large water cavities which are also identification tools. This swimmer moves freely in the water column as it ______________.
A. Smooth gliding motion D. Stalked ciliate
B. Engulfs suspended bacteria E. Swarmer
C. Filter-feeding ciliate F. None of the Above

155. It has a _________________used to trap bacteria and form the food cavities that move throughout the body as digestion occurs.
A. Smooth gliding motion
B. Engulfs suspended bacteria
C. Large feeding groove
D. Stalked ciliate
E. Swarmer
F. None of the Above

156. Paramecium is described as a _______________ because its cilia move and filter bacteria from the water.
A. Smooth gliding motion
B. Engulfs suspended bacteria
C. Filter-feeding ciliate
D. Stalked ciliate
E. Swarmer
F. None of the Above

Vorticella sp.
157. Vorticella is a ___________. There are at least a dozen species found in activated sludge ranging in length from about 30 to 150 -m.
A. Smooth gliding motion
B. Engulfs suspended bacteria
C. Filter-feeding ciliate
D. Stalked ciliate
E. Swarmer
F. None of the Above

158. These organisms are oval to round shaped, have a____________, a domed feeding zone, and a water vacuole located near the terminal end of the feeding cavity.
A. Smooth gliding motion
B. Engulfs suspended bacteria
C. Filter-feeding ciliate
D. Stalked ciliate
E. Contractile stalk
F. None of the Above

159. One organism is found on each stalk except during cell division. After reproducing, the offspring develops a band of swimming cilia and goes off to form its own stalk. The evicted organism is called a "______________."
A. Smooth gliding motion
B. Engulfs suspended bacteria
C. Filter-feeding ciliate
D. Stalked ciliate
E. Swarmer
F. None of the Above

160. Vorticella feeds by producing a _____________with its feeding cilia.
A. Contracting stalk
B. Vortex
C. 150 oval plates
D. Shark teeth
E. Pseudopodia
F. None of the Above

161. The _____________ into its gullet. Vorticella's principal food source is suspended bacteria.
A. Contracting stalk
B. Vortex draws bacteria
C. 150 oval plates
D. Shark teeth
E. Pseudopodia
F. None of the Above

162. The ________________ provides some mobility to help the organism capture bacteria and avoid predators.
A. Contracting stalk
B. Vortex draws bacteria
C. 150 oval plates
D. Shark teeth
E. Pseudopodia
F. None of the Above

163. The ___________ resembles a coiled spring after its rapid contraction. Indicator: If treatment conditions are bad, for example low DO or toxicity, Vorticella will leave their stalks.
A. Stalk
B. Vortex draws bacteria
C. 150 oval plates
D. Shark teeth
E. Pseudopodia
F. None of the Above

164. A bunch of empty ____________ indicates poor conditions in an activated sludge system. Vorticella sp. are present when the plant effluent quality is high.
A. Stalks D. Shark teeth
B. Vortex draws bacteria E. Pseudopodia
C. 150 oval plates F. None of the Above

Euglypha sp.
165. Euglypha (70-100 -m) is a shelled (testate) amoeba. _______________have jelly-like bodies. Motion occurs by extending a portion of the body (pseudopodia) outward.
A. Contracting stalk D. Amoebas
B. Vortex draws bacteria E. Pseudopodia
C. 150 oval plates F. None of the Above

166. ________________have a rigid covering which is either secreted or built from sand grains or other extraneous materials.
A. Contracting stalk D. Shark teeth
B. Vortex draws bacteria E. Pseudopodia
C. Shelled amoebas F. None of the Above

167. Euglypha primarily eats ______________.
A. Contracting stalk D. Shark teeth
B. Bacteria E. Pseudopodia
C. 150 oval plates F. None of the Above

168. Shelled amoebas are common in soil, treatment plants, and stream bottoms where decaying organic matter is present. They adapt to a wide range of conditions and therefore are not good ______________.
A. Rotifer D. Indicator organisms
B. Bacteria E. Euchlanis
C. Shelled amoebas F. None of the Above

Euchlanis sp.
169. This microscopic animal is a typical ___________________.
A. Rotifer D. Corona
B. Bacteria E. Euchlanis
C. Shelled amoebas F. None of the Above

170. The _____________of this Euglypha sp. consists of about 150 oval plates. Its spines project backward from the lower half of the shell.
A. Secreted shell D. Shark teeth
B. Vortex draws bacteria E. Pseudopodia
C. 150 oval plates F. None of the Above

171. Euglypha spines may be single or in groups of two or three. The shell has an opening surrounded by _________________that resemble shark teeth under very high magnification.
A. Contracting stalk D. Shark teeth
B. Vortex draws bacteria E. Pseudopodia
C. 8-11 plates F. None of the Above

172. The shell of Euglypha is often transparent, allowing the hyaline (watery) body to be seen inside the shell. The ____________extend outward in long, thin, rays when feeding or moving.
A. Contracting stalk D. Shark teeth
B. Vortex draws bacteria E. Pseudopodia
C. 150 oval plates F. None of the Above

173. ________________ 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. Rotifer D. Corona
B. Bacteria E. Euchlanis
C. Shelled amoebas F. None of the Above

174. The head area, called the "_________," has cilia that beat rhythmically, producing a strong current for feeding or swimming.
A. Rotifer D. Corona
B. Bacteria E. Euchlanis
C. Shelled amoebas F. None of the Above

175. Euchlanis is an omnivore, meaning that its varied diet includes detritus, bacteria, and small ____________.
A. Rotifer D. Protozoa
B. Bacteria E. Euchlanis
C. Shelled amoebas F. None of the Above

176. _____________ has a glassy shell secreted by its outer skin. The transparent body reveals the brain, stomach, intestines, bladder, and reproductive organs.
A. Rotifer D. Corona
B. Bacteria E. Euchlanis
C. Shelled amoebas F. None of the Above

177. A characteristic of rotifers is their__________________, which is a jaw-like device that grinds food as it enters the stomach. At times the action of the mastax resembles the pulsing action of a heart.
Rotifers, however, have no circulatory system.
A. Rotifers D. Corona
B. Mastax E. Euchlanis
C. Shelled amoebas F. None of the Above

178. Rotifers, however, have no_________________.
A. Rotifers D. Corona
B. Bacteria E. Circulatory system
C. Shelled amoebas F. None of the Above

179. Euchlanis is commonly found in activated sludge when effluent quality is good. It requires a continual supply of dissolved oxygen, evidence that _______________have been sustained.
A. Rotifer D. Corona
B. Aerobic conditions E. Euchlanis
C. Shelled amoebas F. None of the Above

Bacteria Section
180. Some bacteria are basically rods but instead of being straight they are twisted, bent or curved, sometimes in a spiral. These bacteria are called spirilla (singular spirillum). _________ are tightly coiled up bacteria.
A. Rods D. Clumps, chains or planes
B. Bacteria E. Spirochaetes
C. Biofilm F. None of the Above

181. Bacteria are friendly creatures; you never find one bacteria on its own. They tend to live together in clumps, chains or planes. When they live in chains, one after the other, they are called ________________- these often have long thin cells.
A. Rods D. Clumps, chains or planes
B. Bacteria E. Filamentous bacteria
C. Biofilm F. None of the Above

182. When they tend to collect in a plane or a thin layer over the surface of an object, they are called a __________________.
A. Rods D. Clumps, chains or planes
B. Bacteria E. BOD
C. Biofilm F. None of the Above

183. Many bacteria exist as a ________________ and the study of biofilms is very important. Biofilm bacteria secrete sticky substances that form a sort of gel in which they live. The plaque on your teeth that causes tooth decay is a biofilm.
A. Rods D. Clumps, chains or planes
B. Bacteria E. BOD
C. Biofilm F. None of the Above

Filamentous Bacteria
184. Filamentous Bacteria are a type of ____________that can be found in a wastewater treatment system.
A. Facultative D. Long thread-like strands
B. Bacteria E. BOD/COD removal
C. Anaerobic bacteria F. None of the Above

185. They function similar to floc forming bacteria since they degrade ____________ quite well. In small amounts, they are quite good to a biomass.
A. Facultative D. Long thread-like strands
B. Bacteria E. BOD
C. Anaerobic bacteria F. None of the Above

186. They can add stability and a backbone to the _________________that keeps the floc from breaking up or shearing due to turbulence from pumps, aeration or transfer of the water. In large amounts they can cause many problems.
A. Facultative D. Long thread-like strands
B. Bacteria E. Floc structure
C. Anaerobic bacteria F. None of the Above

187. Filaments are bacteria and fungi that grow in _________________ or colonies.
A. Facultative D. Long thread-like strands
B. Bacteria E. BOD/COD removal
C. Anaerobic bacteria F. None of the Above

Site Specific Bacteria
188. Aeration and biofilm building are the key operational parameters that contribute to the efficient degradation of organic matter (________________).
A. Facultative D. Long thread-like strands
B. Bacteria E. BOD/COD removal
C. Anaerobic bacteria F. None of the Above

189. Over time, the application-specific _____________ become site-specific as the biofilm develops and matures and is even more efficient in treating the site-specific waste stream.
A. Facultative D. Long thread-like strands
B. Bacteria E. BOD/COD removal
C. Anaerobic bacteria F. None of the Above

Facultative Bacteria
190. Most of the bacteria absorbing the ______________in a wastewater treatment system are facultative in nature. This means they are adaptable to survive and multiply in either anaerobic or aerobic conditions.
A. Facultative D. Organic material
B. Bacteria E. BOD/COD removal
C. Anaerobic bacteria F. None of the Above

191. The nature of ____________is dependent upon the environment in which they live.
A. Facultative D. Long thread-like strands
B. Individual bacteria E. BOD/COD removal
C. Anaerobic bacteria F. None of the Above

192. Usually, _______________will be anaerobic unless there is some type of mechanical or biochemical process used to add oxygen to the wastewater.
A. Facultative bacteria D. Long thread-like strands
B. Bacteria E. BOD/COD removal
C. Anaerobic bacteria F. None of the Above

193. When bacteria are in the process of being transferred from one environment to another, the metamorphosis from _________________(and vice versa) takes place within a couple of hours.
A. Facultative D. Anaerobic to aerobic state
B. Bacteria E. BOD/COD removal
C. Anaerobic bacteria F. None of the Above

Anaerobic Bacteria
194. __________________live and reproduce in the absence of free oxygen. They utilize compounds such as sulfates and nitrates for energy and their metabolism is substantially reduced.
A. Organic material D. Free oxygen
B. Bacteria E. BOD/COD removal
C. Anaerobic bacteria F. None of the Above

195. In order to remove a given amount of __________________in an anaerobic treatment system, the organic material must be exposed to a significantly higher quantity of bacteria and/or detained for a much longer period of time.
A. Organic material D. Free oxygen
B. Bacteria E. BOD/COD removal
C. Anaerobic process F. None of the Above

196. A typical use for anaerobic bacteria would be in a septic tank. The slower metabolism of the anaerobic bacteria dictates that the wastewater be held several days in order to achieve even a nominal 50% reduction in __________________.
A. Organic material D. Free oxygen
B. Bacteria E. BOD/COD removal
C. Anaerobic process F. None of the Above

197. That is why septic tanks are always followed by some type of effluent treatment and disposal process. The advantage of using the __________________is that electromechanical equipment is not required.
A. Organic material D. Free oxygen
B. Bacteria E. BOD/COD removal
C. Anaerobic process F. None of the Above

198. ______________________release hydrogen sulfide as well as methane gas, both of which can create hazardous conditions. Even as the anaerobic action begins in the collection lines of a sewer system, deadly hydrogen sulfide or explosive methane gas can accumulate and be life threatening.
A. Organic material D. Free oxygen
B. Anaerobic bacteria E. BOD/COD removal
C. Anaerobic process F. None of the Above

Aerobic Bacteria
199. Aerobic bacteria live and multiply in the presence of free oxygen. ________________ always achieve an aerobic state when oxygen is present.
A. Organic material D. Facultative bacteria
B. Bacteria E. BOD/COD removal
C. Anaerobic process F. None of the Above

200. While the name "________________" implies breathing air, dissolved oxygen is the primary source of energy for aerobic bacteria. The metabolism of aerobes is much higher than for anaerobes. This increase means that 90% fewer organisms are needed compared to the anaerobic process, or that treatment is accomplished in 90% less time.
A. Aerobic D. Activated sludge process
B. Aerobic digestion E. BOD/COD removal
C. Anaerobic process F. None of the Above

201. This provides a number of advantages including a higher percentage of organic removal. The by-products of _______________________ are carbon dioxide and water.
A. Aerobic bacteria D. Activated sludge process
B. Aerobic digestion E. BOD/COD removal
C. Anaerobic process F. None of the Above

202. ______________________ live in colonial structures called floc and are kept in suspension by the mechanical action used to introduce oxygen into the wastewater. This mechanical action exposes the floc to the organic material while treatment takes place.
A. Aerobic bacteria D. Activated sludge process
B. Aerobic digestion E. BOD/COD removal
C. Anaerobic process F. None of the Above

203. Following digestion, a gravity clarifier separates and settles out the floc. Because of the mechanical nature of the ____________________ process, maintenance and operator oversight are required.
A. Aerobic bacteria D. Activated sludge process
B. Aerobic digestion E. BOD/COD removal
C. Anaerobic process F. None of the Above

Protozoans and Metazoans
204. In a wastewater treatment system, the next higher life form above bacteria is protozoans. These single-celled animals perform three significant roles in the ____________ process.
A. Bacteria D. Protozoans
B. Metazoans E. BOD/COD removal
C. Activated sludge F. None of the Above

205. These include floc formation, cropping of __________ and the removal of suspended material.
A. Bacteria D. Protozoans
B. Metazoans E. BOD/COD removal
C. Activated sludge F. None of the Above

206. _______________ are also indicators of biomass health and effluent quality. Because protozoans are much larger in size than individual bacteria, identification and characterization is readily performed.
A. Bacteria D. Protozoans
B. Metazoans E. BOD/COD removal
C. Activated sludge F. None of the Above

207. ________ are very similar to protozoans except that they are usually multi-celled animals.
A. Bacteria D. Protozoans
B. Metazoans E. BOD/COD removal
C. Activated sludge F. None of the Above

208. ________________, such as nematodes and rotifers, are typically found only in a well-developed biomass.
A. Bacteria D. Protozoans
B. Metazoans E. Macroinvertebrates
C. Activated sludge F. None of the Above

209. The presence of __________________and metazoans and the relative abundance of certain species can be a predictor of operational changes within a treatment plant.
A. Bacteria D. Protozoans
B. Metazoans E. BOD/COD removal
C. Activated sludge F. None of the Above

210. In this way, an operator is able to make adjustments and minimize negative operational effects simply by observing changes in the _____________ and metazoan population.
A. Bacteria D. Protozoan
B. Metazoans E. BOD/COD removal
C. Activated sludge F. None of the Above

Dispersed Growth
211. ______________ is material suspended within the activated sludge process that has not been adsorbed into the floc particles.
A. Effluent of high quality D. Secondary clarifier
B. Spherical floc particle E. Organic and inorganic particulate material
C. Dispersed growth F. None of the Above

212. This material consists of very small quantities of colloidal (too small to settle out) bacteria as well as _________________________.
A. Effluent of high quality D. Secondary clarifier
B. Spherical floc particle E. Organic and inorganic particulate material
C. Dispersed growth F. None of the Above

213. While a small amount of dispersed growth between the floc particles is normal, excessive amounts can be carried through a _______________. When discharged from the treatment plant, dispersed growth results in higher effluent solids.
A. Effluent of high quality D. Secondary clarifier
B. Spherical floc particle E. Organic and inorganic particulate material
C. Dispersed growth F. None of the Above

Process Indicators

214. Following taxonomic identification, enumeration and evaluation of the characteristics of the various ________________________present in a wastewater sample, the information can be used to draw conclusions regarding the treatment process.

A. Effluent of high quality
B. Spherical floc particle
C. Dispersed growth
D. Secondary clarifier
E. Organisms and structures
F. None of the Above

215. A ______________________indicates immature floc, as would be found during start-up or a process recovery.

A. Effluent of high quality
B. Spherical floc particle
C. Dispersed growth
D. Secondary clarifier
E. Spherical floc particle
F. None of the Above

216. A ______________of irregular shape indicates the presence of a beneficial quantity of filamentous organisms and good quality effluent.

A. Effluent of high quality
B. Spherical floc particle
C. Dispersed growth
D. Mature floc particle
E. Organic and inorganic particulate material
F. None of the Above

217. An excess of dispersed growth could indicate a very young sludge, the presence of toxic material, _________________or an extended period of time at low dissolved oxygen levels.

A. Effluent of high quality
B. Excess mechanical aeration
C. Dispersed growth
D. Secondary clarifier
E. Organic and inorganic particulate material
F. None of the Above

218. Certain protozoans, such as ______________dominate during a system start-up. Free swimming ciliates are indicative of a sludge of intermediate health and an effluent of acceptable or satisfactory quality.

A. Effluent of high quality
B. Spherical floc particle
C. Dispersed growth
D. Amoebae and flagellates
E. Organic and inorganic particulate material
F. None of the Above

219. A predominance of crawling ciliates, stalked ciliates and metazoans is an indicator of sludge with ________________.

A. Effluent of high quality
B. Spherical floc particle
C. Dispersed growth
D. Excellent health and an effluent of high quality
E. Organic and inorganic particulate material
F. None of the Above

Activated Sludge

220. 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 _______________.

A. Sludge
B. Overall process efficiency
C. Organic material
D. An abundance of oxygen
E. Filamentous organisms or Bacteria
F. None of the Above

221. Compared to a septic tank, which takes several days to reduce the organic material, an activated ____________can reduce the same amount of organic material in approximately 4-6 hours.

A. Sludge tank
B. Overall process efficiency
C. Organic material
D. Aeration basin
E. Filamentous organisms
F. None of the Above

222. This allows a much higher degree of _____________. In most cases, treatment efficiencies and removal levels are so much improved that additional downstream treatment components are dramatically reduced or totally eliminated.
A. Sludge
B. Overall process efficiency
C. Organic material
D. Aeration basin
E. Filamentous organisms or Bacteria
F. None of the Above

223. Problems may appear during the operation of activated sludge systems, including:
High solids content in clarified effluent, which may be due to too high or too low solids retention time and to growth of__________________.
A. Sludge
B. Overall process efficiency
C. Organic material
D. Aeration basin
E. Filamentous microorganisms
F. None of the Above

224. Rising sludge, occurring when sludge that normally settles rises back to the surface after having settled. In most cases, this is caused by the denitrification process, where nitrate present in the effluent is reduced to nitrogen gas, which then becomes trapped in the ____________ causing this to float.
A. Sludge
B. Overall process efficiency
C. Organic material
D. Aeration basin
E. Filamentous organisms or Bacteria
F. None of the Above

225. This problem can be reduced by decreasing the flow from the aeration basin to the settling tank or reducing the sludge resident time in the settler, either by increasing the rate of recycle to the aeration basin, increasing the rate of sludge collection from the bottom, or increasing the _____________from the system.
A. Sludge wasting rate
B. Overall process efficiency
C. Organic material
D. Aeration basin
E. Filamentous organisms or Bacteria
F. None of the Above

226. Bulking sludge, that which settles too slowly and is not compactable, caused by the predominance of _______________________.
A. Sludge
B. Overall process efficiency
C. Organic material
D. Aeration basin
E. Filamentous organisms
F. None of the Above

227. This problem can be due to several factors of which the most common are nutrient balance, wide fluctuations in organic load, __________________(too low levels), and an improper sludge recycle rate.
A. Sludge
B. Oxygen limitation
C. Organic material
D. Aeration basin
E. Filamentous organisms or Bacteria
F. None of the Above

228. Insufficient reduction of organic load, probably caused by a low solids retention time, insufficient amount of nutrients such as _____________(rare in fisheries wastewaters), short-circuiting in the settling tank, poor mixing in the reactor and insufficient aeration or presence of toxic substances.
A. Sludge
B. Overall process efficiency
C. P or N
D. Aeration basin
E. Filamentous organisms or Bacteria
F. None of the Above

229. Odors, caused by ______________in the settling tanks or insufficient aeration in the reactor.
A. Sludge
B. Overall process efficiency
C. Organic material
D. Aeration basin
E. Anaerobic conditions
F. None of the Above

Filamentous Organisms

230. The majority of ______________ are bacteria, although some of them are classified as algae, fungi or other life forms. There are a number of types of filamentous bacteria which proliferate in the activated sludge process.

A. Sludge
B. Mass
C. Interfloc bridging
D. Larger floc particles
E. Filamentous organisms
F. None of the Above

231. Filamentous organisms perform several different roles in the process, some of which are beneficial and some of which are detrimental. When __________ are in low concentrations in the process, they serve to strengthen the floc particles.

A. Sludge
B. Mass
C. Interfloc bridging
D. Larger floc particles
E. Filamentous organisms
F. None of the Above

232. This effect reduces the amount of shearing in the mechanical action of the aeration tank and allows the ______________to increase in size.

A. Sludge
B. Mass
C. Interfloc bridging
D. Floc particles
E. Filamentous organisms or Bacteria
F. None of the Above

233. _______________ are more readily settled in a clarifier. Larger floc particles settling in the clarifier also tend to accumulate smaller particulates (surface adsorption) as they settle producing an even higher quality effluent.

A. Sludge
B. Mass
C. Interfloc bridging
D. Larger floc particles
E. Filamentous organisms or Bacteria
F. None of the Above

234. If the filamentous organisms reach too high a concentration, they can extend dramatically from the floc particles and tie one floc particle to another (_____________) or even form a filamentous mat of extra-large size.

A. Sludge
B. Mass
C. Interfloc bridging
D. Larger floc particles
E. Filamentous organisms or Bacteria
F. None of the Above

235. Due to the increased surface area without a corresponding increase in mass, the _____________will not settle well.

A. Activated sludge
B. Mass
C. Interfloc bridging
D. Larger floc particles
E. Filamentous organisms or Bacteria
F. None of the Above

236. This results in less solids separation and may cause a washout of solid material from the system. In addition, air bubbles can become trapped in the mat and cause it to float, resulting in a ______________________.

A. Floating scum mat
B. Mass
C. Interfloc bridging
D. Organic material
E. Filamentous organisms or Bacteria
F. None of the Above

237. Due to the high surface area of the _________________ once they reach an excess concentration, they can absorb a higher percentage of the organic material and inhibit the growth of more desirable organisms.

A. Floating scum mat
B. Mass
C. Interfloc bridging
D. Organic material
E. Filamentous Bacteria
F. None of the Above

Filamentous Bacteria Identification

238. Filamentous Identification should be used as a tool to monitor the health of the __________ when a filament problem is suspected.

A. Floating scum mat D. Organic material
B. Biomass E. Filamentous organisms or Bacteria
C. Interfloc bridging F. None of the Above

239. Filamentous Identification is used to determine the type of ___________present so that a cause can be found and corrections can be made to the system to alleviate future problems.

A. Floating scum mat D. Organic material
B. Mass E. Filamentous organisms or Bacteria
C. Filaments F. None of the Above

240. All ____________ usually have a process control variation associated with the type of filament present that can be implemented to change the environment present and select out for floc forming bacteria instead.

A. Floating scum mat D. Organic material
B. Mass E. Filamentous Bacteria
C. Interfloc bridging F. None of the Above

241. Killing the filaments with chlorine or peroxide will temporarily remove the filaments, but technically it is a band-aid. A process change must be made or the __________will return with time eventually.

A. Floating scum mat D. BOD
B. Mass or Sponge E. Activated sludge process
C. Filaments F. None of the Above

Filamentous Identification

242. Filaments can be internal or external, and they can be free of the __________or found intertwined in the floc.

A. Floating scum mat D. Floc structures
B. Mass or Sponge E. Activated sludge process
C. Filaments F. None of the Above

243. Most labs think that filaments need to be extending from the floc in order to be a problem. This is not true. Internal filaments can cause more problems than____________.

A. Floating scum mat D. External filaments
B. Mass or Sponge E. Activated sludge process
C. Filaments F. None of the Above

244. Think of internal filaments causing a structure like a sponge. It will retain water easily and be harder to dewater, will be hard to compress and will take up more space, thereby increasing ________________.

A. Floating scum mat D. Solids handling costs
B. Mass or Sponge E. Activated sludge process
C. Filaments F. None of the Above

245. ______________ present in the system do not always mean there is a problem. Some filaments are good if they form a strong backbone and add a rigid network to the floc. They help give the floc more structure and settle faster.

A. Floating scum mat D. BOD
B. Mass E. Activated sludge process
C. Filaments F. None of the Above

246. Filaments are good ______________also. They are only a problem when they become dominant. If filament abundance is in the abundant or excessive range, having a Filamentous Identification performed is recommended.
A. Floating scum mat D. BOD degraders
B. Mass or Sponge E. Activated sludge process
C. Filaments F. None of the Above

247. The activated sludge process was invented around 1914 and is today still the most commonly used biological wastewater treatment process. This widespread use is due to the fact that ______________ can be a rather easy process to implement and one that can attain high treatment efficiency.
A. Floating scum mat D. BOD
B. Mass or Sponge E. Activated sludge
C. Filaments F. None of the Above

248. Nocardia amarae, a common cause of disruptive foaming in waste treatment plants, is a slow growing, usually gram-positive, chemoautotrophic, __________, strict aerobe that produces the biosurfactant trehalose.
A. Floating scum mat D. BOD
B. Mass or Sponge E. Activated sludge process
C. Filamentous F. None of the Above

249. ________________can be brown, pink, orange, red, purple, gray or white, so color alone is not a key to identifying this species. N. amarae, member of the Actinomycetes family, is not motile, so it relies on movement of the water to carry it through the system.
A. Floating scum mat D. BOD
B. Mass or Sponge E. Activated sludge process
C. Colonies F. None of the Above

250. It produces_________________, urease and nitrate reductase enzymes, but not casease. The foam from Nocardia amarae is usually a viscous brown color unless algae are entrapped in it, in which case it appears green and brown.
A. Floating scum mat D. BOD
B. Catalase E. Activated sludge process
C. Filaments F. None of the Above

251. ____________________is yet another common cause of disruptive foaming in waste treatment plants, motile in its Hormogonia and sometimes Trichome phases.
A. Mixotrophic D. Sphaeroliticus natans
B. Thiothrix I E. Nostocoida limicola
C. Microthrix parvicella F. None of the Above

252. This __________________________often forms a confluent gel encasing flattened discs or large sheets of cells, forming symbiotic relationships with other species.
A. Mixotrophic D. Sphaeroliticus natans
B. Thiothrix I E. Oxygenic phototrophic species
C. Microthrix parvicella F. None of the Above

253. Staining gram-positive, _____________ produces round cells within tight coil formations. Nostocoida can also be dentified 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. Mixotrophic D. Sphaeroliticus natans
B. Thiothrix I E. Nostocoida
C. Microthrix parvicella F. None of the Above

Thiothrix

254. Thiothrix spp., the second most common cause of disruptive foaming in wastewater treatment plants appears as straight to slightly curved cells with rectangular shape form filaments up to 500 microns in length, in multicellular rigid filaments, staining gram-negative, with obligately ____________.

A. Mixotrophic D. Sphaeroliticus natans
B. Thiothrix E. Aerobic respiration
C. Microthrix parvicella F. None of the Above

255. Thiothrix are _____________, using several small organic carbons and reduced inorganic sulfur sources for growth and energy.

A. Mixotrophic D. Sphaeroliticus natans
B. Thiothrix I E. Obligately aerobic respiration
C. Microthrix parvicella F. None of the Above

256. Thiothrix I is one of the _______________found using phase contrast microscopy at 400 to 1000x magnification.

A. Mixotrophic D. Sphaeroliticus natans
B. Largest filament E. Obligately aerobic respiration
C. Microthrix parvicella F. None of the Above

257. Thiothrix II produces rectangular filaments up to 200 microns in length and is easily identified by their ________________using phase contrast microscopy at 400 to 1000x magnification.

A. Mixotrophic D. Starburst effect formations
B. Thiothrix I E. Obligately aerobic respiration
C. Microthrix parvicella F. None of the Above

Microthrix parvicella

258. Microthrix parvicella is another common cause of ______________in waste treatment plants, producing filaments up to 400 microns in length, easily visualized by phase contrast microscopy at 400x magnification.

A. Mixotrophic D. Sphaeroliticus natans
B. Disruptive foaming E. Obligately aerobic respiration
C. Microthrix parvicella F. None of the Above

259. This species is usually found outside floc, ___________in the system, but can also be found hanging out of the floc.

A. Mixotrophic D. Tangling with structures
B. Thiothrix I E. Obligately aerobic respiration
C. Microthrix parvicella F. None of the Above

Sphaeroliticus natans

260. Sphaeroliticus natans is another filamentous species, and yet it is reputed to increase settleability by_________________, increasing surface area.

A. Mixotrophic D. Sphaeroliticus natans
B. Thiothrix I E. Obligately aerobic respiration
C. Branching between flocs F. None of the Above

261. Cells are straight to___________, up to 1000 microns in length and stain gram-negative. These large cells can be easily visualized by phase contrast microscopy at 100x magnification.

A. Mixotrophic D. Sphaeroliticus natans
B. Slightly curved E. Obligately aerobic respiration
C. Microthrix parvicella F. None of the Above

262. Certain conditions favor the proliferation of filamentous species. A _____________ratio favors filamentous organisms, because their higher ratio of surface area to volume provides them with a selective advantage for securing nutrients in nutrient limited environments.
A. Mixotrophic D. Sphaeroliticus natans
B. Thiothrix I E. Low F/M (food to mass)
C. Microthrix parvicella F. None of the Above

263. When a plant runs___________, the slower growing filaments have a better chance to establish a strong colony.
A. Mixotrophic D. Sphaeroliticus natans
B. Thiothrix I E. An extremely long sludge age
C. Microthrix parvicella F. None of the Above

264. As a strict aerobe, high levels of oxygen are necessary to sustain this species. __________ thrives in temperatures from 17 to 37 deg. C.
A. Mixotrophic D. Sphaeroliticus natans
B. Thiothrix I E. Mesophilic, Nocardia amarae
C. Microthrix parvicella F. None of the Above

265. The presence of high levels of fats, oils and greases or hydrocarbons and phenols, can encourage this species, particularly when insufficient levels of ____________are present to balance these carbon sources.
A. Mixotrophic D. Nitrogen and phosphorus
B. Thiothrix I E. Mesophilic, Nocardia amarae
C. Microthrix parvicella F. None of the Above

Filamentous Bacteria
266. A problem that often frustrates the performance of __________ is bulking sludge due to the growth of filamentous bacteria.
A. Microthrix D. Sphaeroliticus natans
B. Thiothrix I E. Activated sludge
C. Microthrix parvicella F. None of the Above

267. Sludge bulking can often be solved by careful process modifications. However, different filamentous bacteria such as Microthrix, _____________, Nostocoida, Thiothrix or "Type 021N" and others cause bulking for very different reasons.
A. Microthrix D. Sphaerotilus
B. Thiothrix I E. Mesophilic, Nocardia amarae
C. Thiothrix II F. None of the Above

268. Many _________________have not even been given a scientific name yet. Consequently, in order to make the right kind of process modification, knowledge to identify them and experience with the process ecology are required.
A. Microthrix D. Sphaeroliticus natans
B. Thiothrix I E. Filamentous species
C. Microthrix parvicella F. None of the Above

269. The potential for instability with _________ is an acute problem when strict demands on treatment performance are in place.
A. Microthrix D. Sphaeroliticus natans
B. Thiothrix I E. Activated sludge
C. Microthrix parvicella F. None of the Above

PAX - finally, a Fix for Microthrix

270. If you ever experienced an overgrowth of ___________ in your activated sludge plant, you will be aware that it can be very difficult to either eradicate or control.
A. Thiothrix II D. Sphaeroliticus natans
B. Thiothrix I E. Activated sludge
C. Microthrix parvicella F. None of the Above

271. ____________is the most common cause of bulking and foaming in activated sludge plants, and it appears either essentially alone or in the company of other filaments.
A. Microthrix D. Sphaeroliticus natans
B. Thiothrix I E. Activated sludge
C. Thiothrix II F. None of the Above

272. Microthrix foams appear in many of the photographs of aeration basins and clarifiers I have collected all over the world, and many of the plant tours on the Internet show the same brown stable scums associated with this organism. Let's face it, _________is just about everywhere.
A. Microthrix D. Sphaeroliticus natans
B. Thiothrix I E. Activated sludge
C. Thiothrix II F. None of the Above

Microthrix is your enemy - Get to know it!

273. Microthrix fits into the filamentous bacterial classification of___________, which means that it tends to appear in plants with long sludge ages.
A. D.O. levels D. MCRT
B. Thiothrix II E. Low F/M
C. Microthrix parvicella F. None of the Above

274. Lackay et al. (1999) suggested that M. parvicella and its low F/M compatriots ___________, and types 0092, 0041, 1851, 0803 were also encouraged to the point of maximum proliferation by alternating anoxic-aerobic conditions (particularly 30-40% aerobic and 60-70% anoxic).
A. Haliscomenobacter hydrossis D. MCRT
B. Thiothrix I E. Activated sludge
C. Microthrix parvicella (M. parvicella) F. None of the Above

275. Modern plants incorporating denitrification and/or phosphorus removal are obvious candidates for bulking and foaming due to_______________.
A. D.O. levels D. MCRT
B. Thiothrix I E. Activated sludge
C. Microthrix F. None of the Above

276. Of all the filaments creating difficulties in activated sludge plants, it is one of the most easily recognized, but there is a commercial test kit available which uses fluorescent situ hybridization (or "______________") to permit visual identification should one feel the need.
A. FISH D. MCRT
B. Thiothrix I E. Activated sludge
C. Microthrix parvicella (M. parvicella) F. None of the Above

277. The design of plants can play a significant part in the proliferation of scums and foams and there are many common mistakes in plant design which assist organisms like Microthrix by retaining floating masses in dead areas of the plant which have very high ___________values and continuously reseed the biomass.
A. D.O. levels D. MCRT
B. Thiothrix I E. Activated sludge
C. Microthrix parvicella (M. parvicella) F. None of the Above

278. Similarly poor mixing, poorly designed and inadequate aeration systems, cyclic overloading and low process __________ can contribute to the creation of anoxic and anaerobic zones in what are supposed to be aeration basins.
A. D.O. levels D. MCRT
B. Thiothrix I E. Activated sludge
C. Microthrix parvicella (M. parvicella) F. None of the Above

Current Remedial Techniques
279. Jenkins et al. (1993) presented sludge chlorination as a method of choice in the United States to combat filamentous bulking due to any organism. The success of treatment of Microthrix in mixed liquor or foams is poor, due it is believed to resistant filamentous bacteria with hydrophobic cell walls such as M. parvicella and_________________.
A. D.O. levels D. Nostocoida limicola
B. Thiothrix I E. Activated sludge
C. Microthrix parvicella (M. parvicella) F. None of the Above

280. Lakay et al. (1988) obtained only a partial elimination of _____________ bacteria at a high chlorine dose. Hwang and Tanaka found in batch tests that M. parvicella remained intact at very high chlorine doses, while the microbial flocs were completely destroyed.
A. D.O. levels D. MCRT
B. Thiothrix I E. Activated sludge
C. Microthrix parvicella (M. parvicella) F. None of the Above

281. Saayman et al. (1996) examined the use of non-specific chemical treatment in a _________ and assessed the effects of biomass settling characteristics and other operational parameters.
A. Anoxic and anaerobic D. MCRT
B. F/M filaments E. Bulking and foaming
C. BNR plant F. None of the Above

282. While chlorine use was the most effective, it was reported to damage the biomass and cause difficulties in the ____________when dosed at high levels, while ozone and peroxide were less effective in treating settling problems but less of a problem to the biomass.
A. Anoxic and anaerobic D. MCRT
B. F/M filaments E. Bulking and foaming
C. P removal process F. None of the Above

283. In recent times the introduction of selectors has been hailed as a major initiative in the control and elimination of filamentous bacteria (bulking and foaming) and the maintenance of ________________.
A. Anoxic and anaerobic D. MCRT
B. F/M filaments E. Moderate biomass SVIs
C. Microthrix parvicella (M. parvicella) F. None of the Above

284. Evidence on the performance of selectors in controlling low ________________ has been described as both controversial and ambiguous and, in the Netherlands, despite incorporating over 80 selectors in full-scale plants, the percentage of plants with bulking associated with Microthrix parvicella was unchanged.
A. Anoxic and anaerobic D. MCRT
B. F/M filaments E. Bulking and foaming
C. Microthrix parvicella (M. parvicella) F. None of the Above

285. Other experiences with the aerobic selector showed only little success in controlling the growth of M. parvicella in the presence of________, and a comparison of anoxic selectors at five plants in the US has demonstrated that performance and effectiveness varied significantly.
A. Anoxic and anaerobic
B. F/M filaments
C. Long chain fatty acids (LCFA)
D. MCRT
E. Bulking and foaming
F. None of the Above

More on Microthrix
286. Mamais et al. 1998 examined the effect of factors such as temperature, substrate type (easily biodegradable in the form of acetate and slowly biodegradable in the form of oleic acid) on ______________ growth using complete mix with and without selectors (anoxic and anaerobic) and plug flow reactors.
A. Anoxic and anaerobic
B. F/M filaments
C. Microthrix parvicella (M. parvicella)
D. MCRT
E. Bulking and foaming
F. None of the Above

287. The results indicate that low temperatures and substrates in the form of long chain fatty acids favor the growth of ____________________.
A. Anoxic and anaerobic
B. F/M filaments
C. Microthrix parvicella (M. parvicella)
D. MCRT
E. Bulking and foaming
F. None of the Above

288. The plug flow configuration was shown to be quite effective in controlling the growth of M. parvicella and producing a sludge with good settling characteristics, while the presence of a selector, either_______________, had no significant effect on the growth of M. parvicella.
A. Anoxic and anaerobic
B. F/M filaments
C. Microthrix parvicella (M. parvicella)
D. MCRT
E. Bulking and foaming
F. None of the Above

289. Maintenance of low sludge ages (5) days has also been reported to eliminate ___________ because it is a slow growing organism, but this is not always operationally possible.
A. Anoxic and anaerobic
B. F/M filaments
C. Microthrix parvicella (M. parvicella)
D. MCRT
E. Bulking and foaming
F. None of the Above

290. While it is often convenient to group filaments together, it does appear the ___________ has received special attention because of its ability to proliferate.
A. Anoxic and anaerobic
B. F/M filaments
C. Microthrix
D. MCRT
E. Bulking and foaming
F. None of the Above

291. More selective investigation of Microthrix has indicated that it has quite well defined requirements. The nature of Microthrix is such that it has the capability of using long chain fatty acids (oleic acid) and their esters (_____________) (fats and oils) as sources of carbon and energy.
A. Lipids and LCFA
B. Triglycerides of palmitic and stearic acid
C. Microthrix parvicella (M. parvicella)
D. MCRT
E. Polyphosphate for energy
F. None of the Above

292. ____________ are present in all domestic wastewater streams and often constitute a significant part of it. Values of 25-35% of the incoming COD have been reported, and it can support a substantial biomass production in a treatment plant.
A. Lipids and LCFA
B. F/M filaments
C. Microthrix parvicella (M. parvicella)
D. MCRT
E. Polyphosphate for energy
F. None of the Above

293. __________ are generally easily consumed in activated sludge, and the consumption rate of LCFA under aerobic or anoxic conditions has been found to be rapid.
A. LCFA
B. F/M filaments
C. Microthrix parvicella (M. parvicella)
D. MCRT
E. Polyphosphate for energy
F. None of the Above

294. Studies indicate that ___________consumes exclusively long chain fatty acids (LCFA), and that it is able to take up LCFA not only under aerobic, but also under anaerobic and anoxic conditions.
A. Lipids and LCFA
B. F/M filaments
C. Microthrix parvicella (M. parvicella)
D. MCRT
E. Polyphosphate for energy
F. None of the Above

295. It has been reported that M. parvicella is able to out-compete other bacteria particularly well in alternating anaerobic-aerobic and anoxic activated sludge systems. This ability is based on a high uptake and storage capacity for ________ under anaerobic conditions and a subsequent use of the stored substrate for growth with oxygen (or nitrate) as electron acceptor.
A. LCFA
B. F/M filaments
C. Microthrix parvicella (M. parvicella)
D. MCRT
E. Polyphosphate for energy
F. None of the Above

296. Rosetti et al. (2002) carried out an extensive examination of ___________ and found that it was a very versatile organism which could store organic carbon under anaerobic conditions using stored polyphosphate for energy (like the organisms responsible for phosphorus removal).
A. Lipids and LCFA
B. F/M filaments
C. Microthrix parvicella (M. parvicella)
D. MCRT
E. Polyphosphate for energy
F. None of the Above

297. Once exposed to aerobic conditions it would recover rapidly and resume growing. Microthrix has a high storage capacity under all operating conditions (anaerobic, anoxic and anaerobic). It has a high "______________" or low Ks, which means it competes well at low substrate concentration.
A. Lipids and LCFA
B. F/M filaments
C. Microthrix parvicella (M. parvicella)
D. MCRT
E. Substrate affinity
F. None of the Above

298. Most interestingly, __________ has a maximum growth rate near 22° C, zero growth rate at 30° C and is capable of quite reasonably large growth rates at as low as 7° C which gives it a significant advantage in the competition with floc formers during winter in cold climates.
A. Lipids and LCFA
B. F/M filaments
C. Microthrix parvicella (M. parvicella)
D. MCRT
E. Polyphosphate for energy
F. None of the Above

PAX vs. Microthrix parvicella

299. Microthrix parvicella is well-equipped to survive, compete and dominate in all kinds of activated sludge systems. With all of the above in mind, it is pleasing to find that _____________ does have a weakness.
A. PAX or Poly aluminum chloride
B. F/M filaments
C. Microthrix parvicella (M. parvicella)
D. MCRT
E. MLSS concentration
F. None of the Above

300. That weakness is its apparent sensitivity to _______________ dosing, which seems to attack the ability of Microthrix parvicella to use lipids by reducing the activity of extracellular enzymes (lipases) on the surface of the organism rendering the organism relatively uncompetitive
A. PAX or Poly aluminum chloride
B. F/M filaments
C. Microthrix parvicella (M. parvicella)
D. MCRT
E. MLSS concentration
F. None of the Above

301. They also recommended the removal of the ______________before dosing to allow the concentration and time of dosage to be kept at a minimum.
A. PAX or Poly aluminum chloride
B. Morphological modification
C. Scum layer
D. MCRT
E. MLSS concentration
F. None of the Above

302. Removal of the floating sludge layer from the surface before starting _______ application was necessary to ensure specific and rapid impact of Al-salts on M. parvicella.
A. PAX or Poly aluminum chloride
B. Morphological modification
C. Microthrix parvicella (M. parvicella)
D. MCRT
E. MLSS concentration
F. None of the Above

303. In fact, the _____________represents an independent microbial system, into which aluminum can penetrate only at a limited extent.
A. PAX or Poly aluminum chloride
B. Morphological modification
C. Microthrix parvicella (M. parvicella)
D. Stable floating sludge
E. MLSS concentration
F. None of the Above

304. Dosage should be combined with high oxygen concentration in the aeration (i.e. above 2.5 mg/L) and the MLSS concentration low (i.e. under 2.5 g/L) since ______________ competes well at low oxygen levels.
A. PAX or Poly aluminum chloride
B. Morphological modification
C. Microthrix parvicella (M. parvicella)
D. MCRT
E. MLSS concentration
F. None of the Above

305. Of note was that the morphological properties of only __________ changed, apparently leaving the other filaments remaining unaffected.
A. PAX or Poly aluminum chloride
B. Morphological modification
C. Microthrix parvicella (M. parvicella)
D. MCRT
E. MLSS concentration
F. None of the Above

306. It was observed that by adding __________ a morphological modification of the filamentous bacterium M. parvicella occurs. The morphological modification is probably the reason why the hydrophobic property of the filaments decreases.
A. PAX or Poly aluminum chloride
B. Morphological modification
C. Microthrix parvicella (M. parvicella)
D. MCRT
E. MLSS concentration
F. None of the Above

PAX

307. PAX (or PAX-14 or polyaluminium chloride) used for ____________ control is a flocculant or coagulant commonly used in water and wastewater treatment.
A. PAX-14 (PAX) or Polyaluminum chloride
B. Biomass
C. Microthrix
D. Sphaerotilus natans
E. MLSS concentration
F. None of the Above

Proposed Treatment Regime

308. In the fall, to prevent the normal appearance of M.parvicella during the coming winter and to control problems with ___________(winter, spring). Dosage: 0.5-1.5g Al/kgSS/day usually added to return sludge.

A. PAX-14 (PAX) or Polyaluminum chloride
B. Biomass
C. Microthrix parvicella (M. parvicella)
D. Sphaerotilus natans
E. MLSS concentration
F. None of the Above

309. __________should be dosed continuously over the treatment period at the chosen level. Removal of floating sludge before and during dosing is recommended. Microscopic examination of the biomass and regular testing of biomass settling is also a very good idea and the dosing at the chosen remedial rate until a target SVI or preferably DSVI is reached should be the rule.

A. PAX-14 (PAX) or Polyaluminum chloride
B. Biomass
C. Microthrix parvicella (M. parvicella)
D. Sphaerotilus natans
E. MLSS concentration
F. None of the Above

Sphaerotilus natans

Description and Significance

310. _________________ is a filamentous bacterium that is covered in a tubular sheath and can be found in flowing water and in sewage and wastewater treatment plants.

A. PAX-14 (PAX) or Polyaluminum chloride
B. Biomass
C. Microthrix parvicella (M. parvicella)
D. Sphaerotilus natans
E. MLSS concentration
F. None of the Above

311. While this ____________sometimes clogs pipes and causes other similar problems, it does not cause major threat to wastewater treatment plants nor is it known to be pathogentic.

A. PAX-14 (PAX) or Polyaluminum chloride
B. Bacterium
C. Microthrix parvicella (M. parvicella)
D. Sphaerotilus natans
E. MLSS concentration
F. None of the Above

312. They can be rectangular when the cells are tightly packed within the sheath. The _____ are clear and easily observable with indentations.

A. PAX-14 (PAX) or Polyaluminum chloride
B. Biomass
C. Microthrix parvicella (M. parvicella)
D. Cell septa
E. MLSS concentration
F. None of the Above

313. Filaments radiate outward from the floc surface into the bulk solution and can cause sludge settling interference by___________________.

A. PAX-14 (PAX) or Polyaluminum chloride
B. Biomass
C. Inter-floc bridging
D. Sphaerotilus natans
E. MLSS concentration
F. None of the Above

314. The filament is usually___________________. There are no sulfur granules. Poly-ß-hydroxybutric acid (PHB) is frequently observed as dark intracellular granules.

A. Sphaerotilus natans
B. Biomass
C. Neisser staining properties
D. Gram negative and Neisser negative
E. MLSS concentration
F. None of the Above

315. In wastewater that is___________________, an exocellular slime coat may be present. Attached growth is usually uncommon, but may occur when at low growth rate.

A. Sphaerotilus natans
B. Biomass
C. Neisser staining properties
D. Nutrient deficient
E. MLSS concentration
F. None of the Above

316. This filament is usually found in environments where there is low _________ or low nutrients (Nor P).
A. Sphaerotilus natans D. DO
B. Biomass E. MLSS concentration
C. Neisser staining properties F. None of the Above

Control
317. RAS chlorination can be used to get rid of the filaments but process changes should also be made. _______________occurs readily on this type of filament, although the empty sheaths still remain. Sludge wasting is necessary to remove them entirely from the system.
A. Sphaerotilus natans D. Cell lysis
B. Biomass E. MLSS concentration
C. Neisser staining properties F. None of the Above

318. Manipulation of ______________concentration can be used to control the filaments. Nutrient deficient wastes can be checked by effluent values of residual NH3 and o-PO4 and should be supplemented if necessary.
A. Sphaerotilus natans D. F/M and DO
B. Biomass E. MLSS concentration
C. Neisser staining properties F. None of the Above

Rank
319. ___________________ ranks 6th in number of predominance. Typically not found in pulp-mills with activated sludge.
A. Sphaerotilus natans D. DO
B. Biomass E. MLSS concentration
C. Neisser staining properties F. None of the Above

Nostocoida limicola II Identification
320. Medium length, non-motile filaments (100-200 µm). Bent and irregularly coiled filaments with incidental true branching. Knots sometimes seen. _____________________with indentations. Cells are oval or disc shaped (1.2-1.4 µm).
A. Cell septa are clear D. DO
B. Biomass E. MLSS concentration
C. Neisser staining properties F. None of the Above

321. Filaments are found within the floc structure but may occur in the_______________. The filament staining is variable, it is usually Gram negative but sometimes positive and Neisser positive.
A. Sphaerotilus natans D. Bulk solution
B. Biomass E. MLSS concentration
C. Neisser staining properties F. None of the Above

322. Usually easy to identify due to its ______________. Stains entirely purple and looks like stacked discs (or hockey pucks). In industrial wastes, an organism that is Gram negative and Neisser negative occurs.
A. Sphaerotilus natans D. DO
B. Biomass E. MLSS concentration
C. Neisser staining properties F. None of the Above

323. There is no sheath and there are no sulfur granules. ________________ granules are frequently observed as dark intracellular granules. Attached growth is usually uncommon. Three subtypes are known. Resembles M. parvicella except in its Neisser staining properties.
A. Starburst effect D. Poly-ß-hydroxybutric acid (PHB)
B. Gram negative E. Thiothrix I or Thiothrix II
C. Rosettes F. None of the Above

Environment

324. This filament is usually found in environments where there is _____________and the presence of organic wastes. Wastes containing starch seem more selective to this filament. Bulking is more common in industrial wastes. The filament appears to be facultative fermentative, which is unique for most filaments.

A. Low DO or low F/M
B. Gram negative
C. Rosettes
D. Poly-ß-hydroxybutric acid (PHB)
E. Thiothrix I or Thiothrix II
F. None of the Above

Control

325. Manipulation of F/M (usually an increase) and ___________can be used to control the filaments. A selector may be used and chlorination. System changes include changing from a complete mix to plug flow aeration basin configuration.

A. Starburst effect
B. Gram negative
C. DO concentration
D. Poly-ß-hydroxybutric acid (PHB)
E. Thiothrix I or Thiothrix II
F. None of the Above

326. ____________ranks 12th in number of predominance in industry. Typically not found in kraft mills. Common in municipalities.

A. Starburst effect
B. Gram negative
C. Rosettes
D. N. limicola
E. Thiothrix I or Thiothrix II
F. None of the Above

Thiothrix I & II

327. Thiothrix species consist of two types of Thiothrix and they are ____________. Thiothrix filaments are straight or slightly curved with Thiothrix I having an overall length of 100-500 µm and individual cells having a rectangular shape (1.4-2.5 x 3-5 µm).

A. Starburst effect
B. Gram negative
C. Rosettes
D. Poly-ß-hydroxybutric acid (PHB)
E. Thiothrix I or Thiothrix II
F. None of the Above

328. Both types of Thiothrix are found stretching from the floc surface, there is a noticeable septa between cells. Both species are Gram negative and Neisser negative with cells that on occasions have_____________.

A. Starburst effect
B. Sulfur granules
C. Rosettes
D. Poly-ß-hydroxybutric acid (PHB)
E. Thiothrix I or Thiothrix II
F. None of the Above

329. There are additional structures on __________and they include apical gonidia as well as rosettes and a sheath is present, incidental attached growth may be observed. A holdfast may add to the characteristic of radiating out from a common center, the "starburst effect".

A. Starburst effect
B. Thiothrix trichomes
C. Rosettes
D. Poly-ß-hydroxybutric acid (PHB)
E. Thiothrix I or Thiothrix II
F. None of the Above

330. The filament staining is _________ or Gram variable when sulfur granules are present and Neisser negative with Neisser positive granules observed frequently.

A. Starburst effect
B. Gram negative
C. Rosettes
D. Poly-ß-hydroxybutric acid (PHB)
E. Thiothrix I or Thiothrix II
F. None of the Above

331. Exhibits bright sulfur granules in the presence of sulfides under phase contrast (use the S-test). _____________ is frequently observed as dark intracellular granules. No attached growth when extending into the bulk solution.
A. Starburst effect D. Poly-ß-hydroxybutric acid (PHB)
B. Gram negative E. Thiothrix I or Thiothrix II
C. Rosettes F. None of the Above

332. Can form rosettes and the filaments can have gonidia on the tips. ________ are when many filaments radiate outward from a common origin. Prominent heavy sheath. Easy to identify due to its large size.
A. Starburst effect D. Poly-ß-hydroxybutric acid (PHB)
B. Gram negative E. Thiothrix I or Thiothrix II
C. Rosettes F. None of the Above

Similar Organisms
333. _____________is similar when in the bulk solution and with no attached growth, although Type 021N has no sheath.
A. Starburst effect D. Poly-ß-hydroxybutric acid (PHB)
B. Gram negative E. Thiothrix I or Thiothrix II
C. Type 021N F. None of the Above

Environment
334. This filament is usually found in environments where there are limited nutrients (N or P). It can also be found in wastes containing specific compounds with sulfides and/or organic acids or environments with low _________. Sometimes found in plants with high pH in the aeration system.
A. BOD test D. Microbial degradation
B. BOD5 E. TOC
C. DO F. None of the Above

Other Wastewater Treatment Components
Biochemical Oxygen Demand
335. Biochemical Oxygen Demand (BOD or BOD5) is an indirect measure of biodegradable organic compounds in water, and is determined by measuring the __________decrease in a controlled water sample over a five-day period.
A. BOD test D. Microbial degradation
B. BOD5 E. TOC
C. Dissolved oxygen F. None of the Above

336. During this five-day period, aerobic (oxygen-consuming) bacteria decompose organic matter in the sample and consume dissolved oxygen in proportion to the amount of organic material that is present. In general, a high __________ reflects high concentrations of substances that can be biologically degraded, thereby consuming oxygen and potentially resulting in low dissolved oxygen in the receiving water.
A. BOD D. Microbial degradation
B. BOD5 E. TOC
C. DO F. None of the Above

337. The _______________ was developed for samples dominated by oxygen-demanding pollutants like sewage. While its merit as a pollution parameter continues to be debated, BOD has the advantage of a long period of record.
A. BOD test D. Microbial degradation
B. BOD5 E. TOC
C. DO F. None of the Above

Organic Carbon

338. Most _______________in water occurs as partly degraded plant and animal materials, some of which are resistant to microbial degradation.

A. BOD test D. Microbial degradation
B. BOD5 E. Organic carbon
C. DO F. None of the Above

339. ___________________is important in the estuarine food web and is incorporated into the ecosystem by photosynthesis of green plants, then consumed as carbohydrates and other organic compounds by higher animals. In another process, formerly living tissue containing carbon is decomposed as detritus by bacteria and other microbes.

A. BOD test D. Microbial degradation
B. Organic carbon E. TOC
C. DO F. None of the Above

Total Organic Carbon

340. (TOC) bears a direct relationship with biological and chemical oxygen demand; high levels of _____________ can result from human sources, the high oxygen demand being the main concern.

A. BOD test D. Microbial degradation
B. BOD5 E. TOC
C. DO F. None of the Above

Need for Nitrogen and Phosphorus Removal at Wastewater Treatment Plants

Nutrients

341. Nutrients are chemical elements or compounds essential for plant and animal growth. Nutrient parameters include ammonia, organic nitrogen, _____________, nitrate nitrogen (for water only) and total phosphorus.

A. BOD test D. Microbial degradation
B. Kjeldahl nitrogen E. Low levels of nutrients
C. DO F. None of the Above

342. High amounts of nutrients have been associated with eutrophication, or over-fertilization of a water body, while low levels of nutrients can reduce plant growth and (for example) starve higher level organisms that consume ___________________.

A. BOD test D. Microbial degradation
B. Kjeldahl nitrogen E. Phytoplankton
C. DO F. None of the Above

343. Wastewater treatment has generally been defined as containing one or more of the following four processes: (1) preliminary, (2) primary, (3) secondary, and (4) advanced - also known as _________________.

A. Preliminary treatment D. Effluent disinfection
B. Primary treatment E. Secondary treatment
C. Tertiary treatment F. None of the Above

344. _________________ consists of grit removal, which removes dense inert particles and screening to remove rags and other large debris.

A. Preliminary treatment D. Effluent disinfection
B. Primary treatment E. Secondary treatment
C. Tertiary treatment F. None of the Above

345. ____________ involves gravity settling tanks to remove settleable solids, including settleable organic solids.
A. Preliminary treatment D. Effluent disinfection
B. Primary treatment E. Secondary treatment
C. Tertiary treatment F. None of the Above

346. The performance of primary settling tanks can be enhanced by adding chemicals to capture and flocculate smaller solid particles for removal and to ______________.
A. Preliminary treatment D. Effluent disinfection
B. Primary treatment E. Precipitate phosphorus
C. Tertiary treatment F. None of the Above

347. Secondary treatment follows ______________ in most plants and employs biological processes to remove colloidal and soluble organic matter.
A. Preliminary treatment D. Effluent disinfection
B. Primary treatment E. Secondary treatment
C. Tertiary treatment F. None of the Above

348. Effluent disinfection is usually included in the definition of _______________.
A. Preliminary treatment D. Effluent disinfection
B. Primary treatment E. Secondary treatment
C. Tertiary treatment F. None of the Above

349. EPA classifies _______________ as "a level of treatment that is more stringent than secondary or produces a significant reduction in conventional, non-conventional, or toxic pollutants present in the wastewater".
A. Preliminary treatment D. Advanced treatment
B. Primary treatment E. Secondary treatment
C. Tertiary treatment F. None of the Above

350. Other technical references subdivide advanced treatment, using the terms "secondary with nutrient removal" when nitrogen, phosphorus, or both are removed and "_____________" to refer to additional reduction in solids by filters or microfilters.
A. Preliminary treatment D. Effluent disinfection
B. Primary treatment E. Secondary treatment
C. Tertiary treatment F. None of the Above

351. Effluent filtration and nutrient removal are the most common __________processes.
A. Preliminary treatment D. Advanced treatment
B. Primary treatment E. Secondary treatment
C. Tertiary treatment F. None of the Above

Nutrient Impairment of U.S. Waterways

352. The harmful effects of _______________ due to excessive nitrogen and phosphorus concentrations in the aquatic environment have been well documented.
A. Eutrophic conditions D. Nitrogen or Phosphorus
B. Submerged aquatic vegetation or (SAV) E. Phytoplankton and macroalgae
C. Eutrophication F. None of the Above

353. Algae and phytoplankton growth can be accelerated by higher concentrations of nutrients as they can obtain sufficient carbon for growth from carbon dioxide. In addition to stimulating eutrophication, nitrogen in the _______________can exert a direct demand on dissolved oxygen (DO) and can be toxic to aquatic life.
A. Eutrophic conditions D. Form of ammonia
B. Submerged aquatic vegetation or (SAV) E. Phytoplankton and macroalgae
C. Eutrophication F. None of the Above

354. Even if a treatment plant converts ammonia to nitrate by a biological nitrification process, the resultant nitrate can stimulate algae and phytoplankton growth. Phosphorus also contributes to the____________.

A. Eutrophic conditions
B. Submerged aquatic vegetation or (SAV)
C. Growth of algae
D. Nitrogen or Phosphorus
E. Phytoplankton and macroalgae
F. None of the Above

355. Either _____________ can be the limiting nutrient depending on the characteristics of the receiving water.

A. Eutrophic conditions
B. Submerged aquatic vegetation or (SAV)
C. Eutrophication
D. Nitrogen or Phosphorus
E. Phytoplankton and macroalgae
F. None of the Above

356. Nitrogen is typically limiting in estuarine and marine systems and ____________ in fresh water systems.

A. Eutrophic conditions
B. Submerged aquatic vegetation or (SAV)
C. Eutrophication
D. Phosphorus
E. Phytoplankton and macroalgae
F. None of the Above

357. According to the 2007 report Effects of Nutrient Enrichment in the Nation's Estuaries: A Decade of Change, increased nutrient loadings promote a progression of symptoms beginning with excessive growth of ___________ to the point where grazers cannot control growth.

A. Eutrophic conditions
B. Submerged aquatic vegetation or (SAV)
C. Eutrophication
D. Nitrogen or Phosphorus
E. Phytoplankton and macroalgae
F. None of the Above

358. These blooms may be problematic, potentially lasting for months at a time and blocking sunlight to light-dependent ______________.

A. Eutrophic conditions
B. Submerged aquatic vegetation or (SAV)
C. Eutrophication
D. Nitrogen or Phosphorus
E. Phytoplankton and macroalgae
F. None of the Above

359. In addition to increased growth, changes in naturally occurring ratios of nutrients may also affect which species dominate, potentially leading to_________________.

A. Nuisance/toxic algal blooms
B. Submerged aquatic vegetation or (SAV)
C. Eutrophication
D. Nitrogen or Phosphorus
E. Phytoplankton and macroalgae
F. None of the Above

360. These blooms may also lead to other more serious symptoms that affect biota, such as low DO and loss of ___________.

A. Eutrophic conditions
B. Submerged aquatic vegetation or (SAV)
C. Eutrophication
D. Nitrogen or Phosphorus
E. Phytoplankton and macroalgae
F. None of the Above

361. Once water column nutrients have been depleted by phytoplankton and macroalgae and these blooms die, the bacteria decomposing the algae then consume oxygen, making it less available to surrounding_______________.

A. Eutrophic conditions
B. Submerged aquatic vegetation or (SAV)
C. Aerobic aquatic life
D. Nitrogen or Phosphorus
E. Phytoplankton and macroalgae
F. None of the Above

362. Consequently, fish and invertebrate kills may occur due to hypoxia and anoxia, conditions of ______________________.

A. Eutrophic conditions
B. Submerged aquatic vegetation or (SAV)
C. Eutrophication
D. Nitrogen or Phosphorus
E. Low to no DO
F. None of the Above

363. ______________ may also cause risks to human health, resulting from consumption of shellfish contaminated with algal toxins or direct exposure to waterborne toxins.
A. Eutrophic conditions
B. Submerged aquatic vegetation or (SAV)
C. Eutrophication
D. Nitrogen or Phosphorus
E. Phytoplankton and macroalgae
F. None of the Above

364. ___________ can also create problems if the water is used as a source of drinking water.
A. Eutrophic conditions
B. Submerged aquatic vegetation or (SAV)
C. Eutrophication
D. Nitrogen or Phosphorus
E. Phytoplankton and macroalgae
F. None of the Above

365. Chemicals used to disinfect drinking water will react with organic compounds in source water to form____________, which are potential carcinogens and are regulated by EPA.
A. Eutrophic conditions
B. Submerged aquatic vegetation or (SAV)
C. Disinfection byproducts
D. Nitrogen or Phosphorus
E. Phytoplankton and macroalgae
F. None of the Above

Nutrient Constituents in Wastewater and Measurement Methods
Nitrogen
366. ______________ is an essential nutrient for plants and animals. Approximately 80 percent of the earth's atmosphere is composed of nitrogen and it is a key element of proteins and cells.
A. An essential nutrient
B. Per capita contribution
C. Ammonia-nitrogen
D. Nitrogen
E. Total Kjeldahl Nitrogen (TKN)
F. None of the Above

367. The major contributors of _____________ to wastewater are human activities such as food preparation, showering, and waste excretion.
A. An essential nutrient
B. Per capita contribution
C. Ammonia-nitrogen
D. Nitrogen
E. Total Kjeldahl Nitrogen (TKN)
F. None of the Above

368. The per capita contribution of_____ in domestic wastewater is about 1/5th of that for BOD.
A. An essential nutrient
B. Per capita contribution
C. Ammonia-nitrogen
D. Nitrogen
E. Total Kjeldahl Nitrogen (TKN)
F. None of the Above

369. ______________ in domestic wastewater typically ranges from 20 to 70 mg/L for low to high strength wastewater.
A. An essential nutrient
B. Per capita contribution
C. Ammonia-nitrogen
D. Nitrogen
E. Total Nitrogen (TN)
F. None of the Above

370. 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 ________________to the collection system.
A. An essential nutrient
B. Per capita contribution
C. Inflow and infiltration
D. Nitrogen
E. Total Kjeldahl Nitrogen (TKN)
F. None of the Above

371. ____________ in domestic wastewater consists of approximately 60 to 70 percent ammonia-nitrogen and 30 to 40 percent organic nitrogen.
A. An essential nutrient
B. Per capita contribution
C. Ammonia-nitrogen
D. Nitrogen
E. Total Kjeldahl Nitrogen (TKN)
F. None of the Above

372. Most of the _______________ is derived from urea, which breaks down rapidly to ammonia in wastewater influent.
A. An essential nutrient
B. Per capita contribution
C. Ammonia-nitrogen
D. Nitrogen
E. Total Kjeldahl Nitrogen (TKN)
F. None of the Above

373. EPA approved methods for measuring ammonia, nitrate, and nitrite concentration use colorimetric techniques. Organic nitrogen is approximated using the standard method for ______.
A. An essential nutrient
B. Per capita contribution
C. Ammonia-nitrogen
D. Nitrogen
E. Total Kjeldahl Nitrogen (TKN)
F. None of the Above

374. The TKN method has three major steps:
Digestion to convert_______________________;
A. An essential nutrient
B. Per capita contribution
C. Ammonia-nitrogen
D. Nitrogen
E. Organic nitrogen to ammonium sulfate
F. None of the Above

375. Conversion of _______________through addition of a strong base and boiling; and
A. An essential nutrient
B. Ammonium sulfate into condensed ammonia gas
C. Ammonia-nitrogen
D. Nitrogen
E. Total Kjeldahl Nitrogen (TKN)
F. None of the Above

376. Measurement using colorimetric or titration methods. Because the measured concentration includes ammonia, the ammonia-nitrogen concentration is subtracted from the TKN to determine __________.
A. "As nitrogen"
B. Aliphatic N compounds
C. Ammonia-nitrogen
D. Organic nitrogen
E. Total Kjeldahl Nitrogen (TKN)
F. None of the Above

377. Nitrogen components in wastewater are typically reported on an ________basis so that the total nitrogen concentration can be accounted for as the influent nitrogen components are converted to other nitrogen compounds in wastewater treatment.
A. "As nitrogen"
B. Aliphatic N compounds
C. Ammonia-nitrogen
D. Organic nitrogen
E. Total Kjeldahl Nitrogen (TKN)
F. None of the Above

378. WWTPs designed for nitrification and denitrification can remove 80 to 95 percent of__________, but the removal of organic nitrogen is typically much less efficient.
A. "As nitrogen"
B. Inorganic nitrogen
C. Ammonia-nitrogen
D. Organic nitrogen
E. Total Kjeldahl Nitrogen (TKN)
F. None of the Above

379. Domestic wastewater organic nitrogen may be present in particulate, colloidal or dissolved forms and consist of proteins, amino acids, aliphatic N compounds, refractory natural compounds in drinking water (e.g.__________), or synthetic compounds (e.g. ethylene Diamine tetraacetic acid (EDTA)).
A. Humic substances
B. Aliphatic N compounds
C. Ammonia-nitrogen
D. Organic nitrogen
E. Total Kjeldahl Nitrogen (TKN)
F. None of the Above

380. _____________ may be released in secondary treatment by microorganisms either through metabolism or upon death and lysis.
A. "As nitrogen"
B. Aliphatic N compounds
C. Ammonia-nitrogen
D. Organic nitrogen
E. Total Kjeldahl Nitrogen (TKN)
F. None of the Above

381. Some _______________ may be contained in recondensation products. Hydrolysis of particulate and colloidal material by microorganisms releases some organic nitrogen as dissolved, biodegradable compounds.
A. Nitrogen
B. Aliphatic N compounds
C. Ammonia-nitrogen
D. Organic nitrogen
E. Total Kjeldahl Nitrogen (TKN)
F. None of the Above

382. Amino acids are readily degraded during secondary biological treatment, with 90 to 98 percent removal in activated sludge systems and 76 to 96 percent removal in trickling filters. However, other forms of ______________ may be more persistent in wastewater treatment processes.
A. "As nitrogen"
B. Aliphatic N compounds
C. Ammonia-nitrogen
D. Organic nitrogen
E. Total Kjeldahl Nitrogen (TKN)
F. None of the Above

383. The importance of organic nitrogen has increased as effluent limits on nitrogen have become more stringent. With more impaired waterways from nutrient loads, effluent limits for _____________ concentrations of 3.0 mg/L or less are becoming more common.
A. "As nitrogen"
B. Total phosphorus or (TP)
C. Ammonia-nitrogen
D. Total nitrogen or TN
E. Dissolved organic nitrogen or (DON)
F. None of the Above

384. The ______________ concentration in the effluent from biological nutrient removal treatment facilities was found to range from 0.50 to 1.50 mg/L in 80 percent of 188 plants reported by Pagilla and values as high as 2.5 mg/L were observed.
A. "As nitrogen"
B. Total phosphorus or (TP)
C. Ammonia-nitrogen
D. Total nitrogen or TN
E. Dissolved organic nitrogen or (DON)
F. None of the Above

385. Thus, for systems without effluent filtration or membrane bioreactors (MBRs) that are trying to meet a ___________goal of 3.0 mg/L, the effluent DON contribution can easily be 20 to 50 percent of the total effluent nitrogen concentration, compared to only about 10 percent for conventional treatment.
A. "As nitrogen"
B. Total phosphorus or (TP)
C. Ammonia-nitrogen
D. TN treatment
E. Dissolved organic nitrogen or (DON)
F. None of the Above

386. The chemical composition of DON in wastewater effluents is not completely understood. Sedlak has suggested that only about 20 percent of the _____________ has been identified as free and combined amino acids, EDTA, and other trace nitrogen compounds.
A. "As nitrogen"
B. Total phosphorus or (TP)
C. Ammonia-nitrogen
D. Total nitrogen or TN
E. Dissolved organic nitrogen or (DON)
F. None of the Above

387. About 45 percent may be unidentified low molecular weight compounds and the other 35 percent as unidentified high molecular weight compounds containing________________. Similar results were found by Khan.
A. "As nitrogen"
B. Total phosphorus or (TP)
C. Humic acids and amides
D. Phosphorus
E. Dissolved organic nitrogen or (DON)
F. None of the Above

Phosphorus

388. Total phosphorus (TP) in domestic wastewater typically ranges between 4 and 8 mg/L but can be higher depending on industrial sources, water conservation, or whether a detergent ban is in place. Sources of _______________are varied.

A. Orthophosphate fraction
B. Total phosphorus or (TP)
C. Ammonia-nitrogen
D. Total nitrogen or TN
E. Phosphorus
F. None of the Above

389. Some _____________ is present in all biological material, as it is an essential nutrient and part of a cell's energy cycle.

A. Orthophosphate fraction
B. Total phosphorus or (TP)
C. Ammonia-nitrogen
D. Phosphorus
E. Polyphosphate
F. None of the Above

390. ____________ is used in fertilizers, detergents, and cleaning agents and is present in human and animal waste.

A. Orthophosphate fraction
B. Total phosphorus or (TP)
C. Phosphorus
D. Total nitrogen or TN
E. Polyphosphate
F. None of the Above

391. The ____________ is soluble and can be in one of several forms (e.g., phosphoric acid, phosphate ion) depending on the solution pH.

A. Orthophosphate fraction
B. Total phosphorus or (TP)
C. Ammonia-nitrogen
D. Total nitrogen or TN
E. Polyphosphate
F. None of the Above

392. ____________are high-energy, condensed phosphates such as pyrophosphate and trimetaphosphate.

A. Orthophosphate fraction
B. Total phosphorus or (TP)
C. Ammonia-nitrogen
D. Total nitrogen or TN
E. Polyphosphates
F. None of the Above

393. They are also soluble but will not be precipitated out of wastewater by metal salts or lime. They can be converted to ___________ through hydrolysis, which is very slow, or by biological activity.

A. Orthophosphate fraction
B. Total phosphorus or (TP)
C. Ammonia-nitrogen
D. Total nitrogen or TN
E. Polyphosphate
F. None of the Above

394. Organically bound _____________can either be in the form of soluble colloids or particulate. It can also be divided into biodegradable and non-biodegradable fractions.

A. Orthophosphate fraction
B. Total phosphorus or (TP)
C. Ammonia-nitrogen
D. Total nitrogen or TN
E. Phosphorus
F. None of the Above

395. Particulate organically bound _____________ is generally precipitated out and removed with the sludge.

A. Phosphorus
B. Total phosphorus or (TP)
C. Ammonia-nitrogen
D. Total nitrogen or TN
E. Polyphosphate
F. None of the Above

396. Soluble organically bound biodegradable ____________ can be hydrolyzed into orthophosphate during the treatment process.

A. Orthophosphate fraction
B. Total phosphorus or (TP)
C. Ammonia-nitrogen
D. Total nitrogen or TN
E. Phosphorus
F. None of the Above

397. Soluble organically bound non-biodegradable ____________ will pass through a wastewater treatment plant.
A. Orthophosphate fraction
B. Total phosphorus or (TP)
C. Phosphorus
D. Total nitrogen or TN
E. Polyphosphate
F. None of the Above

398. A typical wastewater contains 3 to 4 mg/L phosphorus as ____________, 2 to 3 mg/L as polyphosphate, and 1 mg/L as organically bound phosphorus.
A. Orthophosphate fraction
B. Total phosphorus or (TP)
C. Ammonia-nitrogen
D. Total nitrogen or TN
E. Polyphosphate
F. None of the Above

399. EPA approved laboratory methods rely on colorimetric analysis. Colorimetric analysis measures orthophosphate only, so a digestion step is needed to convert ___________ and organic phosphorus to orthophosphate to measure TP.
A. Orthophosphate fraction
B. Total phosphorus or (TP)
C. Ammonia-nitrogen
D. Total nitrogen or TN
E. Polyphosphate
F. None of the Above

Phosphorus Removal by Chemical Addition
400. The purpose of this section is to describe techniques for ________________by chemical addition. It summarizes issues associated with chemical feed location, mixing, and sludge production.
A. Phosphorus removal
B. Chemical precipitation
C. Enhance floc formation
D. Sludge production
E. Soluble phosphates
F. None of the Above

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