### **INSTRUCTIONS**:

### 1. Write your name on the answer books provided.

#### 2. Write only the correct alphabet against the question number in your answer books provided.

- 1. *Nitroso* type bacteria obtain energy by oxidising
  - a) ammonia
  - b) nitrite
  - c) Sugars

#### 2. Heterotrophs obtain their energy and carbon from

- a) Light
- b) CO2
- c) Organic compounds

3. In the activated sludge process, polyphosphate accumulating bacteria store polyphosphate under \_\_\_\_\_\_ conditions.

- a) aerobic
- b) anoxic
- c) anaerobic

4. Under anaerobic conditions in the activated sludge process the polyphosphate accumulating bacteria can not store

- a) PHB
- b) Glycogen
- c) Polyphosphate

5. What is the name of the national guidelines for drinking water quality?

- a) Australian Drinking Water Guidelines
- b) Australian Water Quality Guidelines
- c) Australian Water Guidelines
- d) Australian Drinking and Waste Water Guidelines

6. What is the most important catchment and treatment issue for the protection of human health in water supplies?

- a) Removal of pathogenic organisms
- b) Removal of chemical contaminants
- c) Removal of carcinogenic compounds
- d) Removal of sewage

7. In the correct order, what are usually the main steps in drinking water treatment?

- a) Sedimentation, Filtration, Coagulation and Flocculation, Disinfection
- b) Sedimentation, Coagulation and Flocculation, Filtration, Disinfection
- c) Disinfection, Sedimentation, Coagulation and Flocculation, Filtration

- d) Filtration, Sedimentation, Coagulation and Flocculation, Disinfection
- 8. Which of the following is NOT a property of an ideal disinfectant?
  - a) Cost effective
  - b) Stable residual
  - c) Produces by-products
  - d) Safe to handle
- 9. What is one factor that would generally NOT effect disinfection?
  - a) pH
  - b) turbidity
  - c) water hardness
  - d) all of the above

10. What indicator organism is used to detect the presence of faecal contamination in water?

- a) Escherichia coli
- b) Salmonella typhi
- c) Cryptosporidium
- d) Enterococcus spp.
- 11. What has had the most significant impact on public health over the past 150 years?
  - a) the discovery of antibiotics
  - b) global warming
  - c) the provision of clean water through wastewater treatment and treated water for drinking
  - d) heart surgery

12. Factors that affect the ability for microorganisms to survive and participate in the activated sludge process include:

- a) the ability to produce storage products
- b) having a growth rate grater than the dilution rate
- c) being a floc former
- d) resisting abiotic factors such as toxins, extreme pH and temperature extremes
- e) all of the above
- 13. Bacteriophages in activated sludge have the role of
  - a) reducing the bacterial population
  - b) becoming human pathogens
  - c) preying on the protozoa
  - d) providing a substrate for protozoa
- 14. The role of protozoa in activated sludge is
  - a) to prey on the bacteria and maintain a reduce biomass
  - b) provide a haven for viruses
  - c) remove all of the carbon
  - d) protect bacteria
- 15. The three stages of anaerobic digestion are (in order of process):

- a) methogenesis -> fermentation -> acetogenesis
- b) fermentation -> acetogenesis -> methanogenesis
- c) acetogenesis -> fermentation -> methanogenesis
- d) methanogenesis -> fermentation -> acetogenesis

16. If you have a group containing different microbial species that can all oxidize ammonia in a given habitat, this group would be called a:

- a) Population
- b) Guild
- c) Community
- d) Ecosystem
- e) Microcosm

17. In the interactions between two populations, synergism is where:

- a) One population benefits while the other is not affected and the association is not obligatory
- b) One population is adversely effected while the other is not affected or benefits
- c) Both populations benefit but the association is not obligatory
- d) Both populations benefit and the association is obligatory
- e) Where neither population benefits

18. An example of commensalism is:

- a) An organism metabolising toxic end products for another organism
- b) Lichen
- c) Protozoa grazing on bacteria
- d) An organism producing antibiotics that kills off another organism
- e) A fermenting organism producing acetate that is used as an electron donor by an anaerobic respiring organism
- 19. Which of the following group of organisms do not have members that can fix carbon:
  - a) Anoxygenic phototrophs
  - b) Oxygenic phototrophs
  - c) Chemoheterotrophs
  - d) Chemolithotrophs
  - e) All of the above have members that fix carbon

20. A process where different microbial taxa work in cooperation to cross feed each other or degrade a compound that neither can perform entirely on their own is called:

- a) Allotrophy
- b) Commensalism
- c) Ammensalism
- d) Syntrophy
- e) Parasitism

21. A cow absorbs \_\_\_\_\_\_ into its bloodstream from the walls of the rumen after microorganisms help digest the grasses and plant material ingested by the cow.

- a) Cellulose
- b) Cellobiose
- c) Glucose
- d) Starch
- e) Volatile fatty acids

22. Why are infectious diseases such as cholera, malaria and dengue fever seen as major threats resulting from climate change?

- a) Warmer conditions will increase the distribution of carriers, vectors and reservoirs of causative agents
- b) Higher temperatures can increase the virulence and evolution of the causative agents of diseases
- c) Increased nutrient levels in coastal waters will mean the causative agents are able to survive for longer periods
- d) All of the above are possible threats

23. Microbes can produce all of the following gases in metabolic processes. Which one is not a greenhouse gas?

- a) Methane
- b) Nitrogen
- c) Nitrous oxide
- d) Carbon dioxide
- e) All are greenhouse gases

24. The conversion of ammonia to nitrate is called:

- a) Nitrogen fixation
- b) Ammonification
- c) Denitrification
- d) Nitrification
- e) Nitrate reduction

25. Which of the following bacteria is a common symbiotic nitrogen fixer forming nodules on the roots of plants?

- a) Nitrosomonas
- b) Rhizobium
- c) Azospirillum
- d) Nitrobacter
- e) Azotobacter

26. Denitrification carried out by dissimilatory nitrate reducers is a process often detrimental to agriculture because:

- a) Nitrogen gas is lost to the atmosphere
- b) Ammonia produced is unable to be used by plants
- c) Ammonia produced increases soil pH
- d) Organic nitrogen produced is unable to be used by plants
- e) Bacteria carrying out the process are plant pathogens

27. The main reason why only certain species of bacteria fix nitrogen is because:

- a) Nitrogen is not usually limiting in the environment so there is little need for microorganisms to fix nitrogen
- b) It is a microaerophilic process
- c) It requires a large amount of energy
- d) Only certain bacteria require a nitrogen source for biosynthetic processes

e) The bacteria need to be able to form cysts or nodules on plants

28. The sulfur/sulfide and iron oxidiser Acidithiobacillus is an important bacterium environmentally because it:

- a) Is responsible for a large proportion organic carbon degradation in sediments
- b) Produces greenhouse gases
- c) Forms biofilms in pipelines
- d) Causes acid mine drainage
- e) Fixes nitrogen

#### 29. The conversion of organic sulfur to sulfide is called:

- a) Sulfide oxidation
- b) Sulfur oxidation
- c) Desulfurylation
- d) Sulfur reduction
- e) None of the above

30. Dissimilatory reduction of Fe3+ to Fe2+ results in:

- a) Energy generation through anaerobic respiration
- b) Formation of iron-containing enzymes and proteins
- c) Non-enzymic precipitation of iron compounds
- d) Chemical solubilisation of iron compounds
- e) None of the above

SCORE (Average) /15: Stratton – 9.6 Greene – 10.9

Question 29 - everyone got this wrong:

- 29. The conversion of organic sulfur to sulfide is called:
  - a) Sulfide oxidation
  - b) Sulfur oxidation
  - c) Desulfurylation
  - d) Sulfur reduction
  - e) None of the above

Question 19 – a majority got this wrong

Which of the following group of organisms do not have members that can fix carbon:

- a) Anoxygenic phototrophs
- b) Oxygenic phototrophs
- c) Chemoheterotrophs
- d) Chemolithotrophs
- e) All of the above have members that fix carbon

Questions 23 to 27 were thematic and were based around nitrogen cycle but not all were answered correctly

## ANSWERS TO THE QUIZ:

1a (ammonia)	2c (organic compd)	3a (aerobic)	4. c (polyphosphate)	5a (AustDriWatGui)
6a (Rem path org)	7b (Sed,CoaFloFilDis)	8c (Prod bye Prod)	9c (Water hardness)	10a ( <i>E. coli</i> )
11c (Clean water)	12e (all of the above)	13a (red bact pop)	14a (prey on bact)	15b (Fer,acet, met)
16b Guild	17c (both but not obli)	18e (acetate)	19c (chemohetero)	20d (Syntrophy)
21e (VFA)	22d (All)	23b (Nitrogen)	24d (nitrification)	25b (Rhizobium)
26a (loss of N <sub>2</sub> )	27c (large e req)	28d (Acid mine)	29c (Desulfurylation)	30a (e generation

# Notes:

## 19c.

Food chain level	Primary	Secondary and tertiary		
Types	Photoautotroph, Chemoautotroph	Photoheterotroph, Chemoheterotroph		
Examples	Plants, algae, and <u>some bacteria</u>	Herbivores, omnivores, and carnivores		
Definition	An organism that is able to form nutritional organic substances from simple inorganic substances such as carbon dioxide.	Heterotrophs cannot produce organic compounds from inorganic sources and therefore rely on consuming other organisms in the food chain.		
What or How they eat ?	Produce their own food for energy.	They eat other organisms to get proteins and energy.		
Phot	oautotroph Yes Energy from light? No U Energy from light? No Energy from light? Energy from light? From light	Yes Energy from light? No Energy From inorganic oxidation? Yes Chemoheterotroph		

#### Classification of organisms based on their metabolism

Energy source	sunlight	photo-			
	Preformed molecules	chemo-			
Electron donor	organic compound		organo-		tranh
	inorganic compound		litho-		-troph
Carbon source	organic compound			hetero-	
	carbon dioxide			auto-	

- 24d. Is a two step process catalyzed by two ubiquitous bacterial groups:
  - STEP 1. Ammonium (NH<sub>4</sub><sup>+</sup>) or ammonia (NH<sub>3</sub>) to nitrite (NO<sub>2</sub><sup>-</sup>) by the ammonium-oxidizing bacteria (AOB) eg genus *Nitrosomonas*
  - STEP 2. nitrite to nitrate (NO<sub>3</sub><sup>-</sup>). The first reaction is oxidation of ammonium to nitrite by the nitriteoxidizing bacteria (NOB) eg genus *Nitrobacter*

<sup>26a.</sup> A relatively small amount of ammonia is produced by lightning. Some ammonia also is produced industrially by the Haber-Bosch process, using an iron-based catalyst, very high pressures and fairly high temperature. But the major conversion of  $N_2$  into ammonia, and

thence into proteins, is achieved by microorganisms in the process called nitrogen fixation (or dinitrogen fixation).

Nitrogenase enzyme complex is highly sensitive to oxygen. It is inactivated when exposed to oxygen, because this reacts with the iron component of the proteins. Although this is not a problem for anaerobic bacteria (see table below), it could be a major problem for the aerobic species such as cyanobacteria (which generate oxygen during photosynthesis) and the free-living aerobic bacteria of soils, such as *Azotobacter* and *Beijerinckia* (see table, below). These organisms have various methods to overcome the problem.

Exan	nples of nitrogen-fixing bacteria (* denotes a photosynthetic I	pacterium)		
Free living		Symbiotic with plants		
Aerobic	Anaerobic (see Winogradsky column for details)	Legumes	Other plants	
Azotobacter Beijerinckia Klebsiella (some) Cyanobacteria (some)*	Clostridium (some) Desulfovibrio Purple sulphur bacteria* Purple non-sulphur bacteria* Green sulphur bacteria*	Rhizobium	Frankia Azospirillum	

- Azotobacter & Rhizobium produce copious amounts of extracellular polysaccharide (less oxygen diffusion)
- Rhizobium produce root nodules, contain leghaemoglobin an oxygenscavenging molecules which shows (pink colour when the active nitrogenfixing nodules of legume roots are cut open). Leghaemoglobin regulates the supply of oxygen to the nodule tissues in the same way as haemoglobin regulates the supply of oxygen to mammalian tissues.
- · Cyanobacteria produce special heterocysts which is impermeable to oxygen