CE 421/521 Environmental Biotechnology   Name:_____
EXAMINATION NO. 1 - October 4, 2005

I. Use D for simple diffusion, F, for facilitated diffusion, and A, for active transport for each of the following compounds or processes (1 point each):

____ oxygen	____ N_2	____ no expenditure of ATP
____ NH_3	____ NH_4^+	____ requires ATP
____ glycerol	____ NO_3^-	____ uses symport
____ glucose	____ Fe^{3+}	____ transport against concentration gradient

II. Directions: Circle the letter corresponding to the best answer (1.5 points each).

1. The hook, basal body, and rotating shaft are components of the bacteria cell
a. peptidoglycan
b. mitochondria
c. flagella
d. pili
e. none of the above

2. Which of the following is generally not stored by procaryotes:
a. hydrogen
b. energy
c. sulfur
d. carbon
e. phosphorus

3. DNA requires Ca^{2+} and Mg^{2+} ions in order to:
a. allow ribosomes to assemble proteins on the "workbench"
b. fold up in a ball
c. initiate new daughter strands
d. signal for start and stop codons
e. none of the above

4. Which of the following is not a part of DNA replication:
a. 20 amino acids added per second
b. unwinding of DNA strands
c. elongation of daughter strands
d. rewinding of daughter strands
e. none of the above

5. Which of the following is not a part of transcription:
a. segment of DNA encodes for enzymes for a sequential series of reactions called an operon
b. a single mRNA contains information for producing a number of related enzymes
c. process of creating messenger RNA (mRNA) from a segment of the DNA blueprint based on start (promoter) and stop signals
d. enzyme repression and induction
e. none of the above

6. A *Col factor* is:
a. 3 sequential bases that specify a particular amino acid
b. a form of carbon and energy storage for bacteria
c. a plasmid that codes for colicin, a compound produced by *E. Coli* that kills competing strains
d. extrachromosomal DNA that codes for xenobiotic compound degradation
e. none of the above

7. Ligases
a. are involved in oxidation reduction reactions
b. transfer of constituents from one compound to another
c. are responsible for hydrolysis of carbohydrates, proteins, and lipids
d. catalyze the addition or removal of constituents
e. are involved in isomer formation
f. join molecules, polymer formation

8. During exponential growth, the optimal growth rate will be limited only by:
a. supplemental nutrients
b. available substrate
c. inherent growth characteristics
d. oxygen
e. any of the above

9. During stationary growth
a. growth will be limited by available substrate
b. decay and growth will be approximately equal
c. maintenance energy will be supplied by internal cellular reserves (i.e., endogenous metabolism)
d. all of the above
e. none of the above

10. Which of the following are not a part of the electron transport system
a. quinones
b. flavoproteins
c. NADPH
d. NADH
e. acetyl CoA

11. The carbon to nitrogen ratio for anaerobic growth of bacteria in highly loaded systems is approximately:
a.   10:1
b.   50:1
c.   100:1
d.   150:1

12.   The formula for bacteria can be estimated as:
a. $C_4H_7S_2N$
b. $C_5H_7O_2N$
c. $C_7S_5O_4N$
d. $C_6H_7O_3N$

13.   In the above formula the phosphorus content can be estimated as:
a.   20% of the nitrogen content
b.   25% of the nitrogen content
c.   30% of the nitrogen content
d.   50% of the nitrogen content

14.   Nitrifiers are sensitive to
a.   DO
b.   temperature
c.   pH
d.   inhibitors
e.   all of the above
f.   b. and d. above

15.   During denitrifcation

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a.   ammonia serves as the electron donor
b.   oxygen serves as the electron acceptor
c.   carbon dioxide serves as the carbon source
d.   all of the above
e.   none of the above

16.   During nitrification
a.   ammonia serves as the electron donor
b.   oxygen serves as the electron acceptor
c.   carbon dioxide serves as the carbon source
d.   all of the above
e.   none of the above

17.   During carbonaceous BOD removal
a.   ammonia serves as the electron donor
b.   oxygen serves as the electron acceptor
c.   carbon dioxide serves as the carbon source
d.   all of the above
e.   none of the above

18.   During denitrification, nitrous oxide reductase converts:
a. NO_3^- ° NO_2^-
b. N_2O ° N_2
c. NO_2^- ° NO
d. NO_2^- ° N_2O

19.   The oxidation of 1 mg/L ammonia-nitrogen to nitrate requires:
a.   7.1 mg/L alkalinity as $CaCO_3$
b.   4.57 mg oxygen
c.   all of the above
d.   none of the above

20.   During dissimilatory sulfate reduction
a.   sulfate is used as a TEA
b.   low molecular weight organics serve as the electron donors
c.   the prevalence of SRB depends on COD:S ratio
d.   SRB compete with methanogens for substrate
e.   all of the above

21. In general, SRB are favored when
a.   the ratio of readily degradable COD to S ratio is high
b.   the ratio of readily degradable COD to S ratio is low
c.   the oxygen concentration is below 2.0 mg/L
d.   the temperature is above 35°C

22. When the spread of disease is across continents, it is called
a.   epidemic
b.   endemic
c.   histemic
d.   pandemic

23.   In reference to public health microbiology, MID refers to the
a.   most immunodeficient disease
b.   modern intern doctor
c.   minimum infective dose

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d.   mild ingestive disorder

24.   Bacterial content of fecal matter is approximately;
a.   0.09%
b.   0.9%
c.   9%
d.   90%

25.   *Yersinia* are bacteria that
a.   are thermotrophic
b.   have snails as intermediate hosts
c.   are well correlated with indicator organisms
d.   cause liver damage
e.   swine act as major reservoirs
f.   all of the above

26.   The infective dose for *Giardia* and *Cryptosporidium* is typically
a.   one organism
b.   1-10
c.   greater than 10^1 but fewer than 10^2
d.   greater than 10^2 but fewer than 10^4

27. The helminth that affects nearly 200 million people worldwide, has part of its life cycle in snails, burrows through the skin, matures in the liver, and is excreted in urine is:
a.   *Ascaris*
b.   *Dracunciliasis*
c.   Guinea Worm
d.   *Schistosoma*

28. During denitrifcation
a.   ammonia serves as the electron donor
b.   oxygen serves as the electron acceptor
c.   carbon dioxide serves as the carbon source
d.   all of the above
e.   none of the above

29. In the discussion paper by Kappel et al. entitled, "Novel application of oxygen-transferring membranes.." the hypothesis of the research was to test whether membranes could be used effectively:
a. for nutrient removal in activated sludge systems
b. for nitrification in anaerobic digesters
c. for oxidation of biomass in nitrification/denitrification activated sludge
d. for aeration of aerobic digesters
e. none of the above

30.   During carbonaceous BOD removal
a.   ammonia serves as the electron donor
b.   oxygen serves as the electron acceptor
c.   carbon dioxide serves as the carbon source
d.   all of the above
e.   none of the above

III. Short Answer
1. (23 pts) Diagram a bioreactor configuration for each of the following treatment objectives. For each configuration indicate the major microbial reactions occurring, what bacteria are

involved, what storage products are involved and whether their concentration is increasing or decreasing, whether there is aeration or not in each reactor, what the terminal electron acceptor and donor are, and where the recycle and recirculation streams are:

a. phosphorus removal
b. nitrification
c. nitrification/denitrification
d. phosphorus removal and nitrification/denitrification

2. (10 pts) Using linear regression, calculate the temperature coefficient from the following. What r^2 value do you get? (Note: $k_2 = k_1 \theta^{(T2 - T1)}$).

Temp, °C	decay coefficient, h^{-1}
5	0.001
7	0.002
10	0.0024
15	0.0035
22	0.0057
28	0.01

3. (10 pts) Discuss the significance of the Monod equation. Include in your discussion what the equation is, how is it determined, what is the best way to determine the parameters in the equation, and how the equation is used in biological wastewater treatment.

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