




UNIVERSITY OF WESTERN ONTARIO  
**BIOLOGY 022**

March 7, 2008      Time: 2 1/2 Hours

Student No. \_\_\_\_\_ Test Room \_\_\_\_\_ Row \_\_\_\_\_

**INSTRUCTIONS - FOLLOW THE CHECK LIST!**

(✓)	<b>On your Scantron sheet</b>		<p>Fill the bubbles completely</p> <ul style="list-style-type: none"><li>• Use <b>HB pencil only</b></li><li>• No stray marks or doodles</li><li>• Make all erasures complete</li></ul> <p><b>Yes</b> - Calculators are permitted (non-programmable only)</p> <p><b>No</b> – Borrowing is not allowed</p>
	<b>Print name</b>	Print clearly	
	<b>Signature</b>	Do your best	
	<b>Instr</b> 	Maxwell, Haffie	
	<b>Course</b>	Bio 22	
	<b>Student number</b>	Print clearly/ Bubble neatly	
	<b>Exam Code</b>	<b>111 – Very important</b>	
	<b>Section</b>	Leave it blank	
	<b>Answer Sheet</b>	Leave it blank	

(✓)	<b>On your Test Book</b>		<p><b>Do not write your name on the cover</b></p> <p>Your Scantron answers will be emailed to your UWO email account within a week.</p> <p>Review copies of this test will posted on WebCT for study purposes.</p>
	<b>Student number</b>	No names please	
	<b>Test Room</b>	The room you're in right now	
	<b>Row number</b>	We will tell you this	
	Indicate your answers in the test book. Leave no questions blank		

- 1) Please place your ID prominently on your desk and sign the attendance sheet when it comes to you.
- 2) There are **56** questions in this test. Check your paper carefully.
- 3) There is only **one** fully correct answer for each question. Part marks may be awarded. **Answer all questions.** We do not subtract wrong from right.
- 4) Indicate your answers in **both** the test paper **and** on the Scantron.
- 5) It is your responsibility to transfer all answers from the test book to the Scantron sheet **within the 2 1/2 hour test period.**
- 6) When finished, **please stay seated** and raise your hand.
- 7) We will collect both your test book and your Scantron sheet

**Warning**

The Scantron marking program has a cheating analysis feature that compares answer patterns for all papers. It alerts us to similarities. We then check seating arrangements.

Do not sit near your study partners or write the same test codes. Keep your work directly in front of you. Please help us avoid any and all misunderstandings during these tests.

**Comments:** Please defend your arguments **on this page only**. Comments will not be accepted after the test.

Circle the best single letter choice for each of the following questions before transferring your answers to your computer sheet.

1. Which of the following factors explains the low abundance of phytoplankton in the southern Pacific Ocean.  
A. Low Iron  
B. High Ammonium  
C. Low Light  
D. Low Temperature  
E. High abundance of predators

---

2. In photosynthesis the absorption of light is used *specifically* to  
A. oxidize water resulting in the release of electrons.  
B. synthesize ATP by oxidative phosphorylation.  
C. reduce  $\text{NADP}^+$  to NADPH by linear electron transport.  
D. excite an electron within a pigment molecule to a higher energy state.  
E. convert carbon dioxide into a three carbon sugar that can be used for growth.

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3. Which of the following statements about photosynthesis is **correct**?  
A. "Resonance Energy Transfer" results in the transfer of electrons between pigment molecules.  
B. The reaction centre of a photosystem lacks chlorophyll.  
C. Rubisco has evolved over time resulting in a decrease in the oxygenation reaction.  
D. A cyanobacterium contains three different genomes.  
E. Cyclic electron flow allows for increased NADPH synthesis.

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4. The "Jagendorf experiment" used isolated thylakoids with buffers of different pH. Which of the following treatments would prevent the experiment from working?  
A. Running the experiment in the dark.  
B. Inhibiting photosystem II function.  
C. Using a membrane ionophore (uncoupler).  
D. Blocking electron transport past ubiquinone (UQ).  
E. Preventing the reduction of  $\text{NADP}^+$ .

---

5. Comparing photosynthetic electron transport (PET) with respiratory electron transport (RET) - which of the following statements is **NOT** correct?  
A. In PET, plastoquinone (PQ) serves a function similar to that of ubiquinone (UQ) in RET.  
B. In PET,  $\text{H}_2\text{O}$  is an electron donor while in RET,  $\text{O}_2$  is the product of electron transport.  
C. In both, the flow of electrons from one carrier to the next is spontaneous.  
D. In PET, plastocyanin (PC) serves a role similar to that of cytochrome *c* in RET.  
E. During PET the lumen becomes acidified (lower pH), in RET the matrix becomes acidified.

---

6. Which of the following statements about the Calvin Cycle is **NOT** correct?  
A. Like the Krebs Cycle, it can operate indefinitely in the dark.  
B. Each  $\text{CO}_2$  combines with one molecule of ribulose biphosphate (RuBP) to form 2 molecules of 3-phosphoglycerate (PGA).  
C. It requires the continuous regeneration of RuBP (ribulose biphosphate).  
D. For every three  $\text{CO}_2$  fixed 6 molecules of glyceraldehyde-3-phosphate (G3P) are synthesized.  
E. Both A and D are statements that are NOT correct.

7. What is the rate of carbon fixation by the Calvin Cycle in a sample of phytoplankton given the following information?

1. the rate of mitochondrial respiration is  $20 \mu\text{mol O}_2 / \text{cell}/\text{sec}$ .
2. The net  $\text{CO}_2$  fixation rate as determined by the  $\text{CO}_2$  analyzer is  $60 \mu\text{mol CO}_2 / \text{cell}/\text{sec}$ .

- A. 0  
B. 20  
C. 40  
D. 60  
E. 80

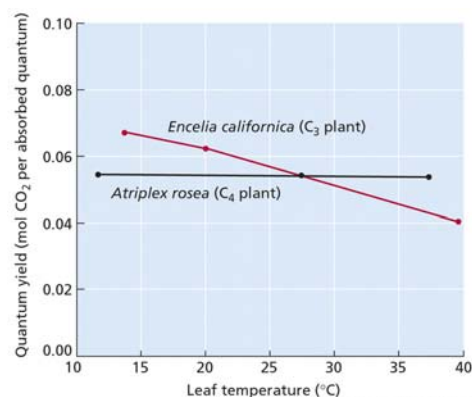


8. Compared to  $\text{C}_3$  plants,  $\text{C}_4$  plants have a lower transpiration ratio because they

- A. have a decreased overall surface area available for evaporation.  
B. don't need to keep their stomata open as long to fix the same amount of  $\text{CO}_2$ .  
C. have a greater quantum yield for photorespiration at high temperatures.  
D. transpire only at low temperature.  
E. only open their stomata at night when temperatures are low.

9. The figure at right shows the efficiency of carbon fixation in both  $\text{C}_3$  and  $\text{C}_4$  plants as a function of leaf temperature. Why at temperatures below about  $25^\circ\text{C}$  are  $\text{C}_3$  plants more efficient than  $\text{C}_4$  plants?

- A. Because unlike  $\text{C}_4$  plants,  $\text{C}_3$  plants don't photorespire.  
B.  $\text{C}_3$  plants lose less  $\text{CO}_2$  through respiration at lower temperatures.  
C. At low temperatures the rate of photorespiration is reduced.  
D.  $\text{C}_3$  plants have a lower ATP requirement.  
E. Both C and D are correct.



10. Both heterocysts and root nodules



- A. contain leghemoglobin.  
B. require  $\text{O}_2$  to support aerobic respiration.  
C. develop in the presence of  $\text{NH}_4^+$ .  
D. display high rates of cyclic photosynthetic electron transport.  
E. Both A and C are correct.

11. In humans,

- A. nitrogenase is found only in mitochondria.  
B. large quantities of ammonia are stored in the cytosol.  
C. the reducing power for nitrogenase comes from NADH not ferredoxin.  
D. usable nitrogen is derived from the breakdown of organic molecules.  
E. nitrogen deficiency results in increased rates of protein synthesis.

12. Which of the following reactions is the basis for why ammonia exposure can cause death?

- A.  $\text{NH}_3 + \text{H}^+ \rightarrow \text{NH}_4^+$
  - B.  $\text{N}_2 \rightarrow \text{NH}_4^+$
  - C.  $\text{NH}_4 \rightarrow \text{glutamine}$
  - D. glutamine  $\rightarrow$  aspartate
  - E.  $\text{NO}_2 \rightarrow \text{NH}_4^+$
- 

13. A sudden drop in the rate of nitrogen fixation by a single-celled cyanobacterium is probably the result of a

- A. over-reduction of the redox state of Ferredoxin (Fd).
  - B. shift from darkness to light.
  - C. increase in glucose transport into the heterocyst.
  - D. increased rate of respiration.
  - E. decrease in the availability of ammonium in vegetative cells.
- 

14. Which of the following statements about partial pressure (P) is **correct**?

- A. The  $P_{\text{CO}_2}$  is higher within an actively respiring mitochondrion than outside.
  - B.  $\text{O}_2$  will move spontaneously from a region of low  $P_{\text{O}_2}$  to a region of high  $P_{\text{O}_2}$ .
  - C. Of all the gases in air,  $\text{O}_2$  contributes the greatest partial pressure.
  - D. The  $P_{\text{O}_2}$  increases with altitude.
  - E. Both B and C are correct.
- 

15. According to Fick's law, the rate of diffusion increases as the

- A. density of the respiratory medium increases.
  - B. respiratory surface area decreases.
  - C. diffusion distance decreases.
  - D. concentration gradient decreases.
  - E. Both B and D are correct.
- 

16. Which of the following statements about gas exchange is **correct**?

- A. The insect tracheal system uses hemoglobin as an oxygen carrier.
  - B. The entire outer surface of a leaf represents the area available for gas exchange.
  - C. Water is a better respiratory medium than air because it holds more oxygen.
  - D. In general, as an organism gets larger its surface area/volume decreases.
  - E. None of the above is correct.
- 

17. Which of the following statements about hemoglobin and  $\text{O}_2$  binding is correct?

- A. About 75% of hemoglobin's  $\text{O}_2$  carrying capacity is used to deliver  $\text{O}_2$  to resting tissue.
  - B. As the partial pressure of  $\text{O}_2$  drops the affinity of hemoglobin for  $\text{O}_2$  increases.
  - C. The higher the  $P_{\text{CO}_2}$  of the blood the lower the affinity of hemoglobin for  $\text{O}_2$ .
  - D. The initial binding of a molecule of  $\text{O}_2$  to one heme subunit decreases the affinity of the remaining heme molecules for  $\text{O}_2$ .
  - E. All of the above are correct.
-

18. Which is a likely consequence of living in hyperoxic conditions?

- A. Increased expression of lactate dehydrogenase.
  - B. Decreased damage to mitochondrial DNA.
  - C. Decreased expression of the enzyme catalase.
  - D. Increased rate of aging.
  - E. Decreased incidence of spontaneous human combustion.
- 

19. Which of the following has been shown to increase life span?

- A. A reduction in total caloric intake
  - B. Mutations to the cytochrome complex in *C. elegans*
  - C. Decrease in SOD expression
  - D. Increased rate of Krebs Cycle
  - E. Consumption of alcohol
- 

20. Which of the following statements about reactive oxygen species (ROS) is **correct**?

- A. Cytochrome oxidase is a major site of ROS generation.
  - B. Superoxide is generated by the two-electron reduction of O<sub>2</sub>.
  - C. A mutation or chemical treatment (such as antimycin) which restricts electron transport results in decreased ROS formation.
  - D. In addition to electron transport, the nucleus is also a major site of ROS generation.
  - E. Old rats on a restricted diet tend to have similar levels of nuclear DNA damage as adult control rats.
- 

21. Endosymbiosis



- A. occurred after the evolution of aerobic prokaryotes
  - B. allowed the development of larger cells.
  - C. explains why mitochondrial chromosomes are circular.
  - D. Both A and B are correct.
  - E. All of the above are correct.
- 

22. Lateral gene transfer

- A. is the movement of genes from one mitochondrion or chloroplast to another.
  - B. is another term used for bacterial conjugation.
  - C. has resulted in the nucleus taking dominant control of chloroplast function.
  - D. has resulted in the transfer of all non-essential genes to the nucleus while all essential genes are maintained in the mitochondrion or chloroplast.
  - E. Occurs during recombination of sister chromatids.
- 

23. The research with *Giardia* and *cpn60* revealed that

- A. all prokaryotes and eukaryotes contain the gene *cpn60*.
  - B. the ancestor of *Giardia* underwent endosymbiosis.
  - C. in humans *cpn60* lacks a known function.
  - D. all eukaryotes possess mitochondria.
  - E. Both B and D are correct.
-

24. Which of the following provides evidence for lateral gene transfer?

- A. DNA polymerase
- B. Phosphofructokinase
- C. Rubisco
- D. Nitrogenase
- E. Glutamate synthase

25. The bacterial chromosome and the F plasmid are similar in that they are both circular, double-stranded, DNA molecules.

What additional characteristic do these two molecules have in common?

- A. Replication from a single origin.
- B. Target for insertion of phage DNA.
- C. Coding for a large number of traits.
- D. Packaged around histone proteins.
- E. Ability to transfer themselves to a recipient cell.



26. Which of the following is **NOT** a requirement for natural genetic exchange of chromosomal DNA in bacteria?

- A. Recombination between donor DNA and recipient chromosome.
- B. A mechanism for transfer of DNA from one cell to another.
- C. Living recipient cells.
- D. Living donor cells.
- E. A and D are correct.



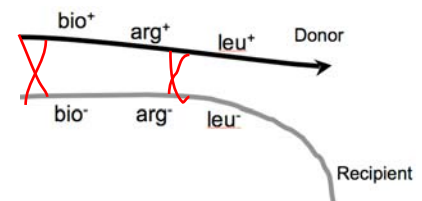
27. During transfer of chromosomal DNA from a bacterial donor to a recipient cell by conjugation (5' end first), the recipient cell would

- A. have its DNA partially degraded.
- B. replicate incoming DNA continuously.
- C. have two copies (alleles) of certain genes.
- D. receive all host genes with equal frequency.
- E. become "Hfr" (High Frequency Recombination).



28. If this figure represents donor and recipient DNA as labelled, how many recombination events would be required (in the recipient) to create a cell that was  $\text{bio}^+ \text{arg}^+ \text{leu}^-$ ?

- A. 1
- B. 2
- C. 3
- D. 4
- E. 6



29. In the classic Lederberg and Tatum experiment involving a mixture of two different mutant strains of bacteria

- A. wild-type cells arose as a result of transduction.
- B. each strain provided amino acids that the other could not produce for itself.
- C. only the recombinants were resistant to antibiotic in the media.
- D. one type of mutant could grow, the other could not.
- E. only wild-type cells could grow on the media.



30. In generalized transduction



- A. every progeny virus picks up a different donor gene.
  - B. all donor cell genes have a similar likelihood of transfer.
  - C. phage DNA integrates into the donor cell chromosome.
  - D. recipient cells are killed by the lytic cycle of the infecting phage.
  - E. errors in recombination result in transfer of bacterial genes from donor to recipient cells.
- 

31. During the lysogenic phase of the lambda phage life cycle

- A. two recombination events are needed to insert the lambda chromosome into that of the host.
  - B. progeny viruses would be produced by transcription.
  - C. the virus integrates into the chromosome of hosts that suffer DNA damage.
  - D. host cells are burst from the inside and progeny phage are released.
  - E. the lambda chromosome is replicated along with the host chromosome.
- 

32. DNA viruses (such a Human papilloma virus) and RNA viruses (such as influenza) are similar in that they are both

- A. replicated in the cytoplasm of host cells.
  - B. associated with increased risk of human cancer.
  - C. replicated by enzymes coded in the host genome.
  - D. composed of nucleic acid surrounded by protein capsids when released from hosts.
  - E. C and D are correct.
- 

33. If the codon for arginine in DNA is 3' GCA, what is the expected sequence of the anticodon on the appropriate tRNA?

- A. 3' GCA
  - B. 3' ACG
  - C. 3' CGU
  - D. 3' CGT
  - E. 3' UGC
- 

34. Of the several different types of information coded in DNA, which type is understood by the cell through complementary base pairing between two different types of RNA?

- A. promoter
  - B. splice signal
  - C. stop codon
  - D. terminator hairpin
  - E. polyadenylation site
- 

35. An *E. coli* enzyme called lactamase is exported from the cell. The gene for lactamase has a "target" sequence that, when translated, creates a peptide signal that directs protein synthesis to ribosomes associated with the cell membrane. Where would you expect to find this target sequence coded in DNA relative to the other components of the gene?

- A. Upstream of the promoter.
  - B. In the 3' UTR.
  - C. Downstream of the start codon.
  - D. In the 5' UTR.
  - E. Downstream of the termination hairpin.
-

36. Gene structure/expression is different in eukaryotes and prokaryotes in that only prokaryotes have a given gene
- coded inside another.
  - present in two copies in a genome.
  - simultaneously transcribed and translated.**
  - translated by more than one ribosome at a time.
  - transcribed by more than one polymerase at a time.
- 
37. Imagine an allele of a gene that, over several generations, is expressed when inherited from fathers but not expressed when inherited from mothers. Analysis of the allele responsible, as found in the DNA of gametes from fathers and mothers, would likely reveal a difference in
- triplet repeat expansion.
  - promoter methylation.**
  - alternative splicing.
  - exon sequence.
  - reading frame.

38. Some strains of bacteria have a single base pair mutation in the anticodon of a tRNA gene. As a result, the mutant tRNA recognizes stop codons.

Which of the following tRNAs could be mutated into one that recognizes the UAA stop codon? (Assume a single base pair substitution mutation. Consult the Genetic Code.)

- Lys**
- Gly
- Pro
- Thr
- Arg

**Second base of codon**

	U	C	A	G	
First base of codon	UUU Phe UUC UUA Leu UUG	UCU Ser UCC UCA UCG	UAU Tyr UAC UAA UAG	UGU Cys UGC UGA UGG Trp	U C A G
	CUU Leu CUC CUA CUG	CCU Pro CCC CCA CCG	CAU His CAC CAA Gln CAG	CGU Arg CGC CGA CGG	U C A G
	AUU Ile AUC AUA AUG Met	ACU Thr ACC ACA ACG	AAU Asn AAC AAA Lys AAG	AGU Ser AGC AGA Arg AGG	U C A G
	GUU Val GUC GUA GUG	GCU Ala GCC GCA GCG	GAU Asp GAC GAA Glu GAG	GGU Gly GGC GGA GGG	U C A G

Third base of codon

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39. Epigenetic changes affect the chemical structure of certain DNA bases. However, such changes are not classified as mutations because they are not
- heritable.
  - affecting coding regions of genes.
  - responsible for the loss of some function.
  - changes in double-stranded DNA sequence.**
  - caused by DNA polymerase failing to proof-read.
- 
40. Removal and replacement of one base from a mismatched base pair that persists after replication is called
- proof-reading.**
  - anticipation.
  - excision repair.**
  - substitution.
  - chromatin acetylation.



41. If you heard that the neurological symptoms of a certain disease were caused by abnormal "ubiquitinylation", you would expect to find cells with unusual

- A. epigenetic "tags".
- B. histone remodelling.
- C. protein degradation.
- D. mRNA processing.
- E. oncogene expression.



42. Given only a long DNA sequence, one might discover where a gene is located (which strand, which reading frame) by looking for the DNA encoding its "stop" codon. How many potential stop codons are coded in the following sequence?

5' AATCCGGCTTCCTGCCCGTATTGTGGTTGGGATGAAGGCCTCCGGGTA 3'  
3' TTAGGCCGAAGGACGGGCATAACACCAACCCTACTTCCGGAGGCCCAT 5'

- A. 0
- B. 1
- C. 2
- D. 3
- E. 4

43. This figure from lecture represents the proposed transfer of the *cbbX* gene from a green *Cyanobacterium* into the nucleus of a eukaryotic cell. (Recall that the *cbbX* gene codes for a protein used in the Calvin Cycle.)



In order to be properly expressed in its new location in the eukaryotic nucleus, this "prokaryotic" *cbbX* gene would need to acquire a

- A. reading frame coded in the opposite direction relative to that of the *Cyanobacterium*.
- B. signal sequence to direct synthesis of the *cbbX* protein to mitochondria.
- C. hairpin transcription terminator.
- D. poly-adenylation sequence.
- E. intron and splice signals.



44. Restriction endonucleases are important in DNA technologies because they cut

- A. the single-stranded "sticky ends" from DNA before insertion into a vector.
- B. the lacZ gene but not antibiotic resistance genes.
- C. unwanted DNA into smaller pieces for disposal.
- D. apart the many copies of DNA created during PCR.
- E. double-stranded DNA at specific sites.



45. Which of the following sequences would be expected in a cDNA library made from mouse skin tumor cells?

- A. 5' UTR of the keratin gene.
- B. enhancer for myc oncogene.
- C. intron of the RNA polymerase gene.
- D. poly-A "tail" of the tRNA for alanine.
- E. promoter of the DNA polymerase gene.



46. The one colony that contains a vector carrying the cloned gene of interest can be isolated from among hundreds of other colonies because it

- A. turns blue.
  - B. has a "smooth" appearance.
  - C. grows on antibiotic plates.
  - D. contains both the vector and the restriction enzyme.
  - E. binds a labelled probe complementary to the gene of interest.
- 

47. An investigation of the genetic basis of the growth of tumor cells may discover an abnormal

- 1. p53 promoter with increased transcription.
- 2. placement of the stop codon in a tumor suppressor gene.
- 3. microRNA that binds to mRNA from a proto-oncogene.
- 4. placement of an enhancer relative to a proto-oncogene.

- A. 1, 2 and 3
  - B. 1 and 3
  - C. 2 and 4
  - D. 4 only
  - E. All
- 



48. The synthesis, processing and function of a given eukaryotic microRNA (miRNA) involves complementary base pairing with

- 1. Dicer RNA
- 2. DNA
- 3. tRNA
- 4. mRNA

- A. 1, 2 and 3
  - B. 1 and 3
  - C. 2 and 4
  - D. 4 only
  - E. All
- 



49. Which of the following cellular components does not have to cross the nuclear membrane to get from where it is manufactured to where it is functional?

- 1. polyA polymerase
- 2. ribosomal protein
- 3. tRNA
- 4. snRNA

- A. 1, 2 and 3
  - B. 1 and 3
  - C. 2 and 4
  - D. 4 only
  - E. All
- 



50. RNA-dependent DNA polymerase is used in the

1. creation of cDNA libraries.
2. polymerase chain reaction (PCR).
3. life cycle of HIV.
4. addition of polyA "tails".

- A. 1, 2 and 3  
B. 1 and 3  
C. 2 and 4  
D. 4 only  
E. All



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**Lab Questions Q51 to Q56 continue below.**

*La/999 people need not do these lab questions.  
Leave them blank as in the previous tests.*

51. Sensory adaptation is a/an \_\_\_\_\_ of a sensation when stimulation is \_\_\_\_\_.

- A. increase; increased  
B. decrease; decreased  
C. decrease; increased  
D. increase; decreased  
E. decrease; constant



52. The t-test is a statistic best used to \_\_\_\_\_.

- A. prove that the null hypothesis is wrong  
B. prove that the null hypothesis is right  
C. compare the means of two groups  
D. compare the number of individuals in two groups  
E. compare the standards of two groups



53. What can we conclude if the t-test value = 3.39 and the critical value = 5.99?

- A. We must repeat statistical analysis until our value of t is greater than the critical value (5.99).  
B. We must accept the alternate hypothesis.  
C. We must gather more data by repeating the experiment.  
D. We must reject the null hypothesis.  
E. Our two samples are not significantly different from each other.



54. Dan samples 5 different populations of a single fish species and wants to use  $X^2$  to determine if there is a difference in predation behaviour among the five populations.

Using a 10% rejection level, which critical  $X^2$  value should we use?

- A. 9.49  
 B. 7.29  
 C. 5.99  
 D. 3.84  
 E. 13.28



Critical values of $X^2$			
Degrees of freedom (n)	p=0.10	p=0.05	p=0.01
1	1.64	3.84	6.64
2	3.22	5.99	9.21
3	4.64	7.82	11.35
4	5.99	9.49	13.28
5	7.29	11.07	15.09
6	8.56	12.59	16.81
7	9.80	14.07	18.48

55. Using the following data, calculate the  $X^2$  value.

- A. 2.8  
 B. 14.66  
 C. 1.02  
 D. 12.2  
 E. 2.1



	Organism A	Organism B	Organism C	Organism D
Expected	20	20	20	20
Observed	12	30	24	12

56. Which of the following techniques that were used to prepare the soil bacterial plates can be classified as being aseptic?

- A. opening the lid of the LB plate only slightly to minimize exposure to air  
 B. not breathing on the LB plate  
 C. sterilizing the cell spreader with ethanol  
 D. heat sterilizing the cell spreader by passing it through the flame  
 E. All A, B, C and D are considered aseptic techniques