

**1. 100 bacterial cells are on leaf in the forest. They go through five doublings (five generations). After the fifth doubling, an amoeba comes along and eats  $\frac{3}{4}$  of all the cells that are present (only  $\frac{1}{4}$ <sup>th</sup> of them are left) and then it wanders off. The remaining cells double three times. How many cells are there at the end?**

- A. 100
- B. 800
- C. 3200
- D. 6400
- E. 128 000

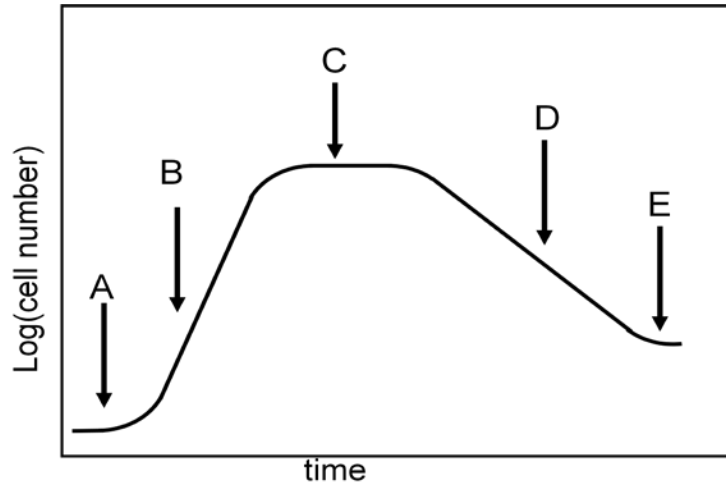
**2. You were supposed to grow a 10 mL culture of bacteria for your laboratory project. You had 20 mL of growth media. You cleverly decided to only use half of it. You grew the cells and they got to  $10^9$  cells/ mL. But then you dropped the flask and you could recover only 0.01 mL. If you add this to the other 10 mL, how many generations do you need to get back to  $10^9$  cells/mL?**

- A. About 10
- B. About 100
- C. About 1000
- D. About 10,000
- E. can't be determined from the data

**3. What is the most important factor explaining the structural integrity of phospholipid bilayers in aqueous solution?**

- A. Maximizing entropy
- B. Ionic bonds
- C. Polar dipole-induced dipole bonds
- D. Induced dipole induced dipole bonds
- E. Covalent bonds

4.



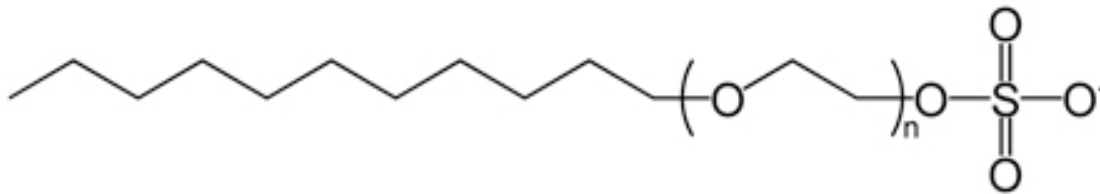
In *culture 1*, in the figure above, cells were added just before the time marked by arrow A. In *culture 1* which arrow points to the portion of the growth curve where no cell division is happening?

- A. The portion marked by arrow A only
- B. The portion marked by arrow C only
- C. The portion marked by arrow D only
- D. The portion marked by arrow A and C
- E. The portion marked by arrow A, C, D

**5. Transport of a solute by active transport only happens in one direction, either in or out of the cell. The basic reason for this lack of symmetry is which of the following?**

- A. Cells have proteins that modify the direction of the transport.
- B. In general, solute only diffuse in one direction.
- C. ATP is only inside the cell.
- D. The orientation of proteins used for active transport is not symmetrical.
- E. Active transport always acts against a concentration gradient.

**6. The chemical structure below is for sodium lauryl sulfate, a commonly used laboratory detergent. If you added this chemical to a culture of bacteria, they lyse. What would be a reasonable cause for this action on the cells?**



- A. Sulfur (S) is a toxic chemical and kills the cells.
- B. The compound dissolves the peptidoglycan.
- C. The compound inserts into the cell membrane because it is amphipathic.
- D. The compound denatures the proteins in the cytoplasm of the cell because the oxygens on the end of the molecule can hydrogen bond to proteins.
- E. The compound prevents cell wall biosynthesis because it is similar in structure to the peptidoglycan.

**7. Why are phospholipids well suited to be the main structural components of membranes?**

- A. They are completely insoluble in water.
- B. They form a structure in which the hydrophobic portion faces outward.
- C. They are made from atoms that are commonly available in foods.
- D. They form a single sheet in water.
- E. They form a selectively permeable structure.

**8. When in solution, a molecule that moves slowly across an artificial membrane moves rapidly across a living cell membrane (regardless of whether the concentration of this molecule is higher inside or outside the cell). Using this information, which transport mechanism is most likely to be responsible for the movement of the molecule across a cell membrane?**

- A. facilitated diffusion
- B. exocytosis
- C. Phagocytosis
- D. simple diffusion
- E. active transport

**9. Which of the following statements is true about passive diffusion?**

- A. Passive diffusion operates independently of concentration.
- B. Passive diffusion phenomena can never reach equilibrium.
- C. Passive diffusion requires no expenditure of cellular energy.
- D. Passive diffusion moves molecules into a cell, but not out of the cell.
- E. Passive diffusion does not occur in the human body.

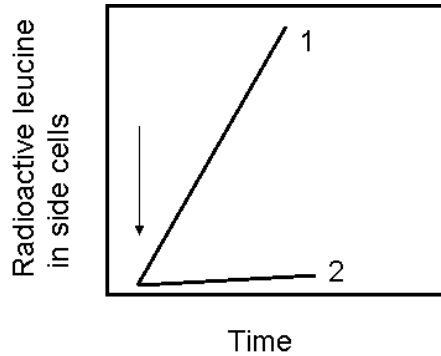
**10. If the transport of molecules of a particular solute from inside a cell across the cell membrane to the outside always requires energy, then which of the following is true?**

- A. The concentration of the solute is higher inside the cell than outside it.
- B. A transport protein is involved in the movement of the molecules.
- C. The concentration of the solute is lower inside the cell than outside it.
- D. The lipid bilayer is permeable to the solute.
- E. All of the above are true

**11. You are hiking in the woods and you suffer a particularly nasty, dirty wound. Unfortunately, you have forgotten your first aid kit, but you seem to recall that packing a large amount of sugar into the wound might help to prevent a bacterial infection. Which of the following would be a rationale for this idea?**

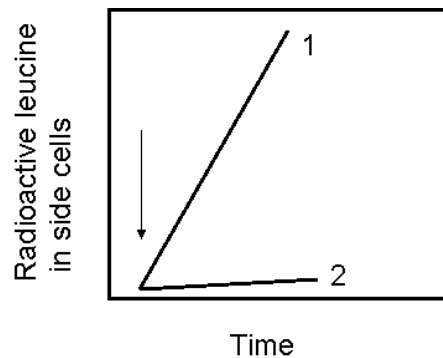
- A. The sugar kills the bacteria by dehydration.
- B. All of the above are good rationales.
- C. The sugar will cut off the air supply to the invading bacteria.
- D. The sugar will make it difficult for the invading bacteria to diffuse.
- E. The sugar will give you skin cells energy to fight the infection.

12. The figure below shows two experiments of the uptake of leucine into cells that are mesophiles and measured using the method described in the lectures. Leucine was added at the arrow. The two curves show the uptake at two different temperatures. For curve 1, the temperature was 35°C and for curve 2, the temperature was 15°C.



From this data which of the conclusions can you make?

1. The transport mechanism is active transport.
  2. The transport mechanism is facilitated diffusion.
  3. The transport mechanism is passive diffusion.
  4. The cytoplasmic membrane is more permeable to leucine at low temperature.
  5. The cell growth rate decreased at low temperature.
- A. None of the conclusions.  
B. All of the conclusions.  
C. Only the conclusion 1 can be made.  
D. Only conclusion 4 can be made.  
E. Only conclusion 5 can be made.



13. The figure above shows two experiments of the uptake of the amino acid tryptophan (radioactive and added at the arrow) into cells measured using the method described in the lectures. For curve 1, radioactive tryptophan alone was added. For curve 2, the cells had been incubated with KCN (potassium cyanide) which blocks ATP synthesis for 3 minutes before testing. Which of the following is the most likely explanation of the differences between the two curves?

- A. KCN binds to the phosphate groups on the phospholipids in the cytoplasmic membrane, reducing the permeability
- B. Tryptophan is taken up by facilitated diffusion and this is the expected pattern.
- C. Tryptophan is taken up by an active transport system, and this is the expected pattern.
- D. KCN binds to tryptophan making it too big to diffuse through the membrane.

14. Which of the following correctly explains why Gram positive bacteria are more susceptible to lysozyme than Gram negative bacteria?

- A. Gram positive bacteria do not have a cell wall where as Gram negative bacteria do.
- B. The peptidoglycan in Gram negative bacteria is more highly crosslinked.
- C. Gram positive bacteria contain teichoic acid in their cell wall which increases the permeability to lysozyme.
- D. Gram negative bacteria have an outer membrane where as Gram positive bacteria do not.
- E. Gram negative bacteria have more peptidoglycan layers to protect the cell from lysozyme.

15. Which of the following is a reasonable reason why low temperature tends to reduce the growth rate of a prokaryotic cell?

- A. It hardens the NAM-NAG cross link bonds of the peptidoglycan of the cell such that the cell cannot grow larger.
- B. It decreases the relative amount of nutrients in the environment such that the cell is not capable of further growth.
- C. The hydrocarbon tails in the phospholipid bi-layer "stiffen" and prevent the ability to transport required nutrients.
- D. The hydrophobic tail ends of the phospholipid bi-layer become kinked and therefore prevent the passage of nutrients.
- E. The cell needs to expend energy to keep warm reducing the energy needed for biosynthesis.

**16. In information storage and transfer are the critical functions of nucleic acids. Which of the following is/are important characteristics of the sugar phosphodiester ester linkages in the backbone of DNA and RNA for the information storage function?**

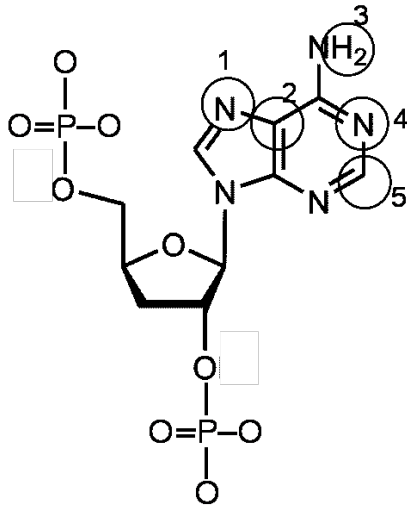
- 1) it is a high energy bond allowing for the rapid synthesis.
- 2) it is ionic allowing the molecule to be readily water soluble.
- 3) it allows free rotation so the molecules can form a secondary structure.
- 4) it is asymmetric so that the strands have an overall orientation.

- A. All of the above.
- B. Only 2 is significant.
- C. 1, 2, and 3 are all important.
- D. Only 1 and 3 are important.
- E. Only 4 is important.

**17. Choose the *BEST* answer that explains how the two strands of DNA are held together.**

- A. The sugar-phosphate backbone holds DNA together.
- B. Only H-bonds between complementary bases of the two strands hold DNA together.
- C. The strands are twisted around each other and can't get apart and this fact holds DNA together.
- D. Stacking interactions between neighboring bases of the same strands and H-bonds between complementary bases of the two strands that hold DNA together.
- E. The combination of H-bonds between complementary bases of two strands hold DNA together.

18. Here is a picture of one of the bases in DNA (this is deoxyadenosine). Which of the circled atoms could make hydrogen bonds with water?



- A. All 5
- B. 1, 2, 3 only
- C. 1, 3, 5 only
- D. 1, 3, 4 only
- E. 3, 4 only

19. Which one of the following statements is not true about enzymes?

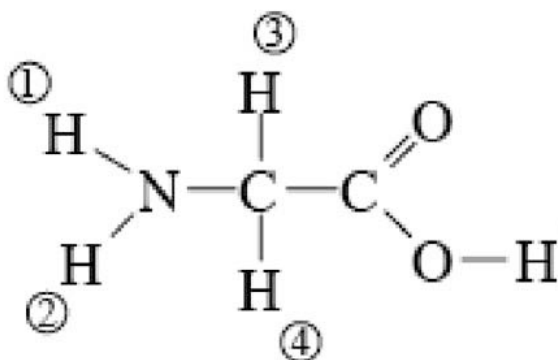
- A. Most enzymes are proteins.
- B. An enzyme is used up by the chemical process it carries out.
- C. An enzyme is very specific in terms of which substrates it can bind to.
- D. An enzyme lowers the activation energy of a chemical reaction.
- E. None of the above is true

20. If the tertiary structure of an enzyme is changed, which one of the following would be true?

- A. Its substrate may not fit properly in the active site.
- B. It will be missing one of its polypeptides.
- C. The helical coil will be stretched out.
- D. The product of the reaction will be a different molecule.
- E. Its substrate will bond covalently with the wrong part of the molecule.

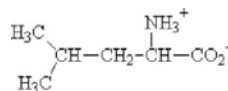
21. Amino acids are often divided into hydrophilic and hydrophobic types. Hydrophilic amino acids would be able to engage in hydrogen bonds with water. Consider the structure of the amino acid glycine shown below.

If glycine was added to a beaker of water, which of the numbered atoms could form H-bonds with water?



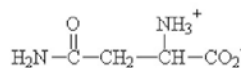
- A. 1, 2 only
- B. 3, 4 only
- C. 1, 3 only
- D. 2, 4, only
- E. All of 1, 2, 3, 4

22. The structures of 5 amino acids are shown below. Imagine that a particular leucine is in a hydrophobic region of a protein and by mutation, one of the other amino acids is substituted for that leucine. Which substitution would have the least effect?



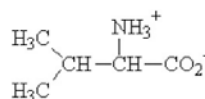
L-leucine  
leu

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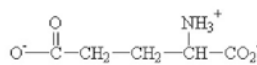
L-asparagine  
asn

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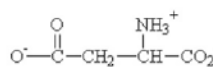
L-valine  
val

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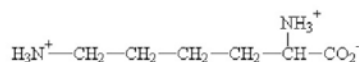
L-glutamic acid  
glu

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L-aspartic acid  
asp

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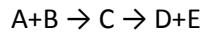
L-lysine  
lys

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- Asparagine
- Valine
- Aspartic acid
- Glutamic acid
- Lysine

23. In describing DNA or RNA, you will see the term 5' to 3' (verbally, this is "5-prime to 3-prime"). The terms 5' and 3' refer to which of the following?

- One of the two DNA strands.
- The sequence of the bases in the DNA or RNA.
- The direction of the strands.
- Particular carbon atoms on the ribose or deoxyribose ring.
- The linkage between the ribose ring and the base.

**24. Suppose an enzyme carries out the following reaction:**

A+B is converted by an enzyme to an intermediate called C and then that is converted to two products D and E.

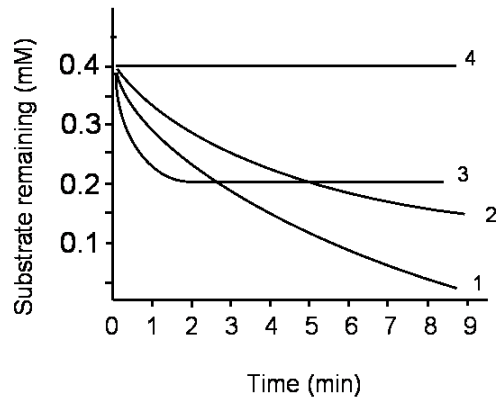
Suppose it is possible to get your chemist friend to artificially synthesize C. If you add a lot of C to a mixture of A and B and the enzyme, what do you suppose would happen?

- A. Not much, the enzyme binds A and B as substrates and it still would.
- B. Not much, the enzyme acts as a catalyst so adding C has little effect.
- C. Conversion of A and B to C would be slowed, but C would be converted to D and E.
- D. The conversion of A and B to D and E would speed up.
- E. It would depend on the temperature so it's hard to say.

**25. Some RNA molecules in cells can act like enzymes because they can catalyze chemical reactions. DNA is usually thought to not do this. What might be the reason for this difference?**

- A. The 2' OH group is probably very chemically reactive.
- B. RNA molecules are usually shorter and therefore more active.
- C. DNA molecules are chemically more stable and so are less likely to stimulate reactions.
- D. Single strand regions on RNA have more exposed chemical groups.
- E. A cell contains more RNAs than DNAs giving more chances of a catalytic molecule.

26. An enzymatic experiment was conducted at 4 different temperatures. The following graph shows the amount of substrate remaining each minute after the enzyme was added to the substrate. Based on your knowledge of enzymes and effect of temperature on enzymatic activity, rank the trials 1, 2, 3, 4 from the lowest temperature to the highest temperature (assume identical pH with identical substrate and enzyme concentrations initially for all three trials).



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

27. Sterols in the eukaryotic membrane accomplish which of the following?

- A. They act as permeases for essential nutrients such as 'fats'.
- B. They buffer the lipid tails keeping the ion concentration correct
- C. They allow water passage because they have OH groups
- D. They reduce membrane permeability.
- E. They maintain the shape of the membrane

28. Which of the following are functions of RNA in Bacteria?

- 1) Act as catalysts for most biochemical reactions
- 2) Act as a carrier for amino acids during protein synthesis
- 3) Transmit genetic information to offspring
- 4) Act as a template in protein synthesis.

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

**29. You have found that a particular protein binds to DNA and through some nifty tricks you have identified the sequence of 8 places where it binds.**

The sequences where it binds are:

Position	1	2	3	4	5	6
	T	A	G	T	C	A
	A	A	G	A	C	A
	T	T	A	A	G	A
	T	G	T	C	A	T
	C	T	G	A	A	C
	T	A	A	T	C	A
	T	C	G	G	C	A
	T	T	T	A	C	A

Which of the following is the consensus base in position 4?

- A. A
- B. G
- C. C
- D. T
- E. there is no consensus.

**30. What determines where the E. coli RNA polymerase initiates transcription?**

- A. An RNA:RNA duplex forms at a consensus sequence 5' of the transcription start site.
- B. Transcription begins at the first AUG codon of each gene.
- C. There is a single unique origin of transcription on the E. coli chromosome.
- D. The sigma factor binds to consensus sequences upstream of the transcription start site.
- E. A general transcription factor binds to the right place and the polymerase binds to it.

**31. The key element that sets the translation frame involves interaction between:**

- A. the ribosome and the mRNA only.
- B. the tRNA and the initiation amino acid methionine.
- C. the ribosome and the tRNA only.
- D. the RNA polymerase and the ribosome.
- E. the RNA polymerase and the promoter.

**32. A region of DNA is transcribed and the mRNA is translated into a sequence of amino acids. The sequence of amino acids coded for by this strand is NH<sub>2</sub> - serine - alanine - lysine - leucine - COOH. What is the order of bases in the template strand of DNA for this region?**

See your Freeman text for codon table. If applicable, this will be provided for you in the exam.

- A. 5' - TCTCGTTTGTTA - 3'
- B. 5' - UCUGCAAAGUUA - 3'
- C. 5' - AGACGTTTCAAT - 3'
- D. 3' - AGACGTTTCAAT - 5'
- E. 3' - TCTCGTTTGTTA - 5'

**33. The following sequence of bases in a portion of a region of DNA is transcribed and the mRNA is translated. What would be the sequence of amino acids coded for by this portion of DNA?**

3' - ATTACGCTTGC - 5'

- A. Translation would stop at the first codon.
- B. NH<sub>2</sub> - alanine - lysine - arginine - asparagine – COOH
- C. NH<sub>2</sub> - asparagine - cysteine - valine - serine – COOH
- D. NH<sub>2</sub> - asparagine - arginine - lysine - alanine – COOH
- E. can't tell

**34. What is the function of aminoacyl-tRNA synthetases?**

- A. catalyze peptide-bond formation between two amino acids
- B. correctly align an mRNA codon with a tRNA anticodon
- C. modify the bases in tRNAs by methylation or deamination
- D. excise incorrect amino acids from a nascent polypeptide
- E. attach an amino acid to its cognate tRNA