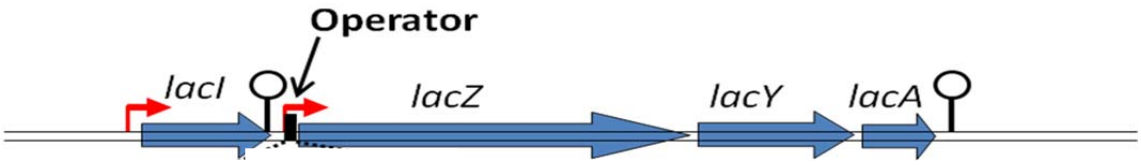
1. **Which of the following statements about regulation of the *lac* operon of *E. coli* is NOT correct?**

   A. The LacI protein binds to the operator and inhibits transcription of the *lac* operon.
   B. When grown in media with only glucose, *E. coli* produce very little *lacZYA* mRNA.
   C. The LacI protein will change shape in the presence of lactose.
   D. Cells that contain a mutant LacI protein that cannot bind lactose are unable to metabolize lactose.
   E. When cells are grown in medium that contains only lactose, the LacI protein, after binding to lactose, will bind near the promoter for the *lac* operon.

2. **A well-characterized mutant of *E. coli* has a deletion in the sequence of DNA that starts at and includes the transcription terminator of the *lacI* gene and continues to just past the operator of the *lac* operon. Which of the following statements describes what will happen in this mutant?**



   A. The cells will be unable to use lactose to grow.
   B. The cells will contain an unusually high level of LacZ and LacY but only when grown in medium with lactose.
   C. The cells will contain LacZ, LacY and LacA even if there is no lactose in the medium.
   D. The absence of the LacI protein will prevent the expression of the *lac* operon.
   E. The mutation will have no effect at all on the regulation of the lac operon.

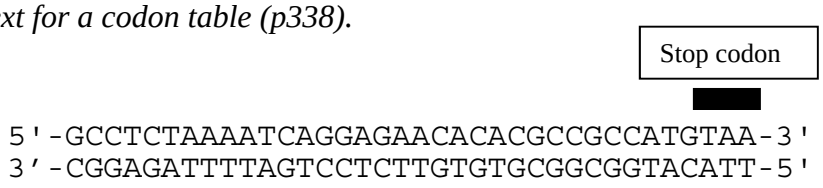
3. **Which of the following *correctly* describes the comparison of typical bacterial and eukaryotic mRNAs?**

   A. Eukaryotic mRNAs have 5' untranslated regions, but bacterial mRNAs do not.
   B. Eukaryotic mRNAs are spliced before translation but bacterial mRNAs are not.
   C. Eukaryotic mRNAs have several open reading frames, but bacterial mRNAs have only one.
   D. Bacterial RNA polymerases are the same as RNA polymerases in eukaryotes.
   E. Eukaryotic mRNAs can accommodate several ribosomes, but bacterial mRNAs cannot.

4. **Operons allow bacteria to express genes that encode proteins with related functions quickly at the same time and in the same amounts. Which of the following would explain why eukaryotes don't employ operons?**

   A. Eukaryotes don't express genes with related functions.
   B. In eukaryotes, genes with related functions are translated from one mRNA by alternate splicing.
   C. Translation of a coding region requires a 5'cap structure.
   D. Genes with related functions are likely to be found on different chromosomes.
   E. Translation and transcription take place separately in eukaryotes.

5. The following nucleotide sequence encodes the C terminus of a protein. There is a mutation in the CODING strand sequence from 5'-GCCTCTAA-'3 to 5'-GCCTCTTA-3'. This results in a change of sequence in the template strand. What is the consequence of this mutation? *See your Biological Science text for a codon table (p338).*



A. The mutation would result in a shorter protein.
B. The mutation would result in a different amino acid being inserted into the protein.
C. The mutation would result in a longer protein.
D. The mutation would not change the amino acid sequence of the protein.
E. NONE of the above.

6. The fact that translation is not simultaneous with transcription in eukaryotes is primarily due to:

A. the requirement that introns are spliced from eukaryotic mRNAs before translation.
B. the fact that eukaryotic mRNAs need a polyA tail.
C. the fact that eukaryotic mRNAs need a 5' cap to be translated.
D. the fact that the processed mRNA transcript is exported to the cytoplasm before translation.
E. the requirement that the DNA must be decondensed before transcription.

7. A mutation in MalT protein caused a change in its tertiary structure. The mutated protein can bind to the operator without binding maltose. What would be the result?

A. The mutated protein would prevent MalPQ from ever being expressed.
B. There would be a decrease in expression of MalPQ but maltose would need to be present to cause expression of MalPQ.
C. There would be expression of MalPQ all the time.
D. There would be an increase expression of MalPQ but only when maltose is present.
E. This mutation would have no effect on MalPQ expression.

8. Information storage and transfer are the critical functions of nucleic acids. What characteristic of the sugar phosphodiester backbone contributes to the information storage ability of DNA?

1) It has high energy bonds allowing for catalytic interactions.
2) The ionic properties cause the molecule to be readily water soluble.
3) Hydrophobic interactions between the bases stabilize the double stranded helix.
4) It is asymmetric so that the strands have a specific orientation.

A. All of the above.
B. 2 only.
C. 1, 2 and 3.
D. 1 and 3.
E. 4 only.

9. 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 holds the two strands of DNA together.

10. Suppose an enzyme carries out the following reaction:

A+B → C → D+E

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

If you add a surplus of C to a mixture containing substrates A, B and the enzyme, what do you expect will 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 affected while 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.

11. 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 3' OH group is probably very chemically reactive.
B. Single strand regions on RNA have more exposed chemical groups.
C. DNA molecules are chemically more stable and so are less likely to stimulate reactions.
D. RNA molecules are usually shorter and therefore more active.
E. A cell contains more RNAs than DNAs giving more chances of a catalytic molecule.

12. A region of DNA is transcribed and the mRNA is translated into a sequence of amino acids. The sequence of amino acids that is encoded by this strand is:

NH_2 - serine - alanine - lysine - leucine - COOH.

What is the order of bases in the template strand of DNA? *See your text for a codon table.*

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

13. You have found that a particular protein binds to a specific sequence of bases in the DNA of a bacterial cell. There are six possible sequences for this binding site.

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.

14. The DNA sequence below is part of the coding region of a gene. What would be the sequence of amino acids for by this portion of DNA (the reading frame is indicated by the vertical lines)? *See your Biological Science text for a codon table.*

3' – ACG|ATT|CTT|TGC - 5'

A. NH_2 C alanine - lysine - arginine - asparagine – COOH
B. NH_2 – cysteine - asparagine - valine - serine – COOH
C. NH_2 – asparagine - phenylalanine - lysine - alanine – COOH
D. NH_2 – cysteine – COOH
E. More information is needed to answer this question.

15. In a bacterium, 14% of the DNA nucleotides were found to be Thymine. What proportions of the other bases would you expect to be present in this particular DNA?

A. 14% A, 0% C, 36% G
B. 14% A, 36% C, 14% U
C. 14% A, 36% C, 36% G
D. 28% A, 365 C, 0% G
E. Cannot be determined.

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

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

17. Which of the following is good evidence for the wobble hypothesis (codon-anti-codon interaction)?

A. The genetic code is a triplet.
B. There are three different termination codons.
C. The tRNAs are translators of protein synthesis.
D. Wobble controls the number of proteins translated from each mRNA.
E. There usually fewer than 60 different types of tRNA in a cell.

18. Which of the following statements about translation in bacteria are true?

1) Proteins called initiation factors contribute to the interaction between the RNA in ribosome small subunit and the ribosomal binding site on the mRNA.
2) Initiation factors mediate the interaction between the N-formylmethionine aminoacyl tRNA and the AUG codon on the mRNA.
3) During elongation, tRNAs enter at the A site, move to the P site, then exit from the E site.
4) The RNA in the ribosome catalyzes formation of peptide bonds.
5) A release factor ends protein synthesis by binding to the stop codon and linking a carbohydrate to the polypeptide chain, preventing any more peptide bonds from forming at the end of the chain.

A. 1, 3 and 5.
B. 1, 3 and 4.
C. 2 and 4.
D. 2, 3 and 5.
E. 2, 3, 4 and 5.

19. A large protein may have as many as 1,500 amino acids in its polypeptide chain. If this protein was denatured (e.g. by increasing the temperature), it may not refold on its own (e.g. by decreasing the temperature). Which of the following might be a reasonable hypothesis for this observation?

1) Some proteins require the assistance of other proteins to fold properly.
2) The proteins must fold as they are being synthesized by the ribosome.
3) Folding is completely determined by the sequence of amino acids.
4) The tertiary structure of the proteins depends on the amino acid sequence.

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

20. Which of the following describes what happens *during* peptide bond formation on the ribosome?

A. The amino acid attached to the tRNA in the P site is transferred to the amino acid attached to the ribosome.
B. The amino acid attached to the tRNA in the A site is transferred to the tRNA in the P site.
C. The amino acid attached to the tRNA in the A site is inserted between the amino acid attached to the tRNA in the P site and the tRNA in the P site.
D. The amino acid attached to the tRNA in the P site is covalently linked to the amino acid attached to the tRNA in the A site.

21. What is the function of aminoacyl-tRNA synthetases?

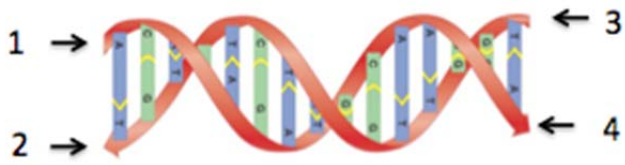
A. They assist the folding of the tRNA into a cloverleaf structure.
B. They modify the bases in tRNAs by adding acetyl groups.
C. They correctly align an mRNA codon with a tRNA anticodon.
D. They catalyze peptide-bond formation between two amino acids.
E. They covalently attach an amino acid to the correct tRNA.

22. Which of the following statements best explains the observation that cells use two steps (transcription and translation) for protein synthesis, instead of just one?

1) There are more places to control protein synthesis.
2) More proteins can be produced in a given time period.
3) Ribosomes are too large to interact with DNA.
4) DNA does not have the sequence that codes for a ribosome binding site.

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

23. The picture below represents two strands of a complementary double stranded DNA. The ends are numbered. If the end numbered "1" represents the 5' end of the strand, which of the following describes the end numbered "4"? [Biological Science Fig 4.7]



A. The 5' end of the other strand.
B. The 3' end of the other strand.
C. The 5' end of the same strand.
D. The 3' end of the same strand.
E. It cannot be determined from this picture.

24. An mRNA sequence at the start of the coding region of a gene is found to be transcribed as:

AUG GGG AGU AAA UUU

The DNA encoding this region would be correctly written as:

A. 3' ATGGGGAGTAAATTT 5'
5' TACCCCTCATTTAAA 3'

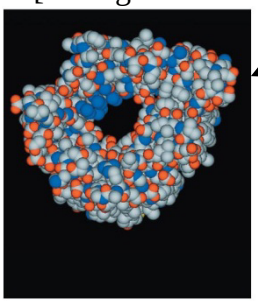
B. 5' ATGGGGAGTAAATTT 3'
3' TACCCCTCATTTAAA 5'

C. 5' TTTAAATGAGGGGAT 3'
3' AAATTTACTCCCCTA 5'

D. 3' TTTAAATGAGGGGAT 5'
5' AAATTTACTCCCCTA 3'

E. None of the above are correct.

25. **The picture below represents the tertiary structure of an outer membrane porin protein from Gram negative bacteria.**
[Biological Science Fig. 3.10 (b)]



The outer surface of the porin that spans the lipid bilayer is likely to have:

A. many positively charged R groups (side chains) on the amino acids.
B. many negatively charged R groups (side chains) on the amino acids.
C. many polar but uncharged R groups (side chains) on the amino acids.
D. many non-polar R groups (side chains) on the amino acids.

26. The inner opening of the porin protein in question #25 would best to be described as:

A. An alpha helix.
B. A water filled channel.
C. A permease.
D. A beta pleated sheet.

27. The porin in question #25 would most likely allow the diffusion of:

A. Small hydrophobic molecules.
B. Small charged molecules.
C. Small hydrophilic molecules.
D. Large uncharged molecules.

28. The diagram below schematically depicts the coupling of transcription and translation in bacteria. Which of the labels in this figure is INCORRECT?
(Note: not all of the proteins being made are shown).

A. Template for transcription.
B. 5' end of mRNA.
C. The first ribosome to bind onto the mRNA molecule.
D. The amino terminus of the newly synthesized polypeptide.
E. The direction of ribosome movement.