1) Which of the following statements concerning proteins is CORRECT?

a) Proteins with multiple subunits take on a quaternary structure.

b) Alpha helical structures are stabilized by hydrogen bonding between the carbonyl oxygen and the amide hydrogen of amino acids on adjacent strands.

c) Phosphodiester bonds link amino acids together in a protein.

d) In parallel beta sheets, adjacent protein chains run in the opposite orientation.

e) The secondary structure of proteins refers to the sequence of amino acids found in the protein.

2) Which of the following lists contains only nonpolar amino acids AND gives the correct one-letter code for the amino acids?

a) Aspartic acid (D) and tyrosine (Y).

b) Alanine (A), Proline (P) and Tryptophan (T).

c) Isoleucine (I), Valine (V) and Serine (S).

d) Glutamine (Q), Asparagine (N) and Lysine (L).

e) Methionine (M) and Cysteine (C).

3) Which of the following techniques DOES NOT involve complementary base pairing?

a) DNA sequencing.

b) Ligating a fragment of DNA with sticky ends into a plasmid.

c) Use of DNA microarrays to look for gene expression.

d) PCR reactions.

e) Electrophoretic mobility shift assays (EMSA).
4) Which CORRECT statement can be made concerning DNA replication in prokaryotes?

a) An RNA primer is required for DNA replication of the bacterial chromosome.

b) DNA replication is unidirectional from one origin of replication.

c) RNA polymerase starts to transcribe from the TAC sequence on the template strand.

d) An ARS sequence isolated from yeast could be used in place of the origin found on the bacterial chromosome.

e) DNA ligase is the enzyme that adds nucleotides onto the growing daughter strand.

5) The tree of life has three primary branches: bacteria, archaea and eukaryotes. Which of the following is CORRECT?

a) Metabolism in Archaea most closely resembles that found in eukaryotes.

b) Humans and plants are found far apart in the tree of life.

c) Bacteria are generally larger in size in comparison to eukaryotic cells.

d) Archaea have the most complex cellular structure.

e) All three branches arose from a common ancestor cell.

6) Which of the following makes up thymidine triphosphate? Give a complete list.

(1) uracil
(2) thymine
(3) ribose
(4) deoxyribose
(5) 1 phosphate only
(6) 3 phosphates

a) 1, 3, 5
b) 3, 4, 6
c) 2, 3, 6
d) 2, 4, 6
e) 1, 3, 4, 6
7) **Which is a DIFFERENCE in the structure of DNA compared to RNA?**

   a) RNA can never be double-stranded like DNA.
   
   b) The base is attached to C1 in DNA, but not in RNA.
   
   c) The 5’ end of RNA has a phosphate group, which is not true of DNA.
   
   d) Thymine is present in DNA, not RNA.
   
   e) There is an hydroxyl group attached to the 3’ end in DNA, but not in RNA.

8) Temperature-sensitive mutants are used to study the function of proteins. Assume a temperature-sensitive mutant for topoisomerase II was made with yeast cells. At room temperature the topoisomerase II behaves normally, but at 37°C, topoisomerase II is inactive. **What would happen when the mutant cells that were growing normally at room temperature were grown at 37°C?**

   a) DNA that was replicated would remain tangled and be unable to separate.
   
   b) During DNA replication, the telomeres would get shorter.
   
   c) Okasaki fragments would not be made.
   
   d) The DNA in the cells would separate into single strands and completely uncoil.
   
   e) The cells would lose the ability to make single-strand breaks in DNA.

9) **Which of the following concerning chromatin structure is CORRECT?**

   a) There are 8 types of histones that are found in chromatin.
   
   b) Histones are rich in arginine and aspartic acid, which neutralizes the charge.
   
   c) Chromatin exists in its most highly condensed form in interphase.
   
   d) The carboxyterminal tails of histones project out from the DNA-histone core.
   
   e) Nucleosomes consist of DNA and a histone octomer.
10) If the antibody used in a chromatin immunoprecipitation assay recognized deacetylated histones, which of the following would be observed?

a) DNA sequences representing the control regions of all genes would be detected.

b) The immunoprecipitated chromatin would be in the least condensed form.

c) The immunoprecipitate would likely contain repressor transcription factors.

d) The immunoprecipitated chromatin would represent the 3’ end of protein-coding genes.

e) The immunoprecipitate would likely contain coactivator proteins.

11) You use a DNA microarray (containing thousands of different cDNAs) to compare the mRNA levels in two groups of cells. One group of cells has been incubated with serum, while the other group of cells has not. You prepare cDNA from both groups of cells and label the cDNA from serum-treated cells with a red fluorochrome and the cDNA from the untreated cells with a green fluorochrome. The labelled cDNAs are mixed and applied to the microarray. Which of the following statements concerning the microarray is CORRECT?

a) Red spots would represent all of the genes that are expressed in serum-treated cells.

b) Red spots would represent serum proteins that interact with the DNA that has been spotted on the microarray.

c) There would be no black spots because all possible genes are expressed in all cell types at all times.

d) Green spots would represent genes whose expression is repressed by serum treatment.

e) Yellow spots would represent mRNAs that are not expressed during serum treatment.
12) Suppose that you want to compare your opsin amino acid sequence with opsin sequences from other organisms to see how much variation there is in the amino acid sequence in the protein. **Which of the following is the BEST way to do this?**

- a) Do a BlastN using your amino acid sequence, copy the sequences with the highest Blast Scores and lowest E-values, and do a ClustalW alignment with all sequences including yours.
- b) Do a BlastP using your amino acid sequence, copy the sequences with the highest Blast Scores and lowest E-values, and do a ClustalW alignment with all sequences including yours.
- c) Do a BlastP using your amino acid sequence, copy the sequences with the highest Blast Scores, and do a ClustalW alignment with all sequences including yours.
- d) Do a BlastN using your amino acid sequence, copy the sequences with the highest E-values, and do a ClustalW alignment with all sequences including yours.
- e) None of the above.

13) DNA replication in *E. coli* is carefully regulated. **Which of the following is CORRECT concerning this process?**

- a) Replication does not begin until the large subunit of DNA polymerase is phosphorylated.
- b) The origin is recognized by the sigma factors that bind tightly to it.
- c) The degree of methylation of the origin partly regulates DNA replication.
- d) Single-strand binding proteins bind to the origin to initiate replication.
- e) DNA at the origin must be positively supercoiled before DNA replication can begin.
14) Which type of cells does your textbook describe as “having made a switch from hunting to farming” and why?
   a) Plant cells because ancestral cells engulfed chloroplasts, which provide energy.
   b) Fungi because ancestral cells engulfed mitochondria, which provide energy.
   c) Animal cells because they evolved from single cells to multicellular organisms that can farm.
   d) Protists because ancestral cells engulfed mitochondria, which provide energy.
   e) None of the above.

15) The following is a diagram showing a linear chromosome. The numbered boxes are used to label the single-strand DNA ends of the chromosome. To which ends would telomerase add nucleotides if it was active in the cell? Include all possibilities.

   5’----------------------------------------------------------------------------------3’
   3’----------------------------------------------------------------------------------5’

   a) 1, 2, 3, 4
   b) 1, 4 only
   c) 3 only
   d) 2, 3 only
   e) 4 only

16) Which of the following could NOT be reliably used to identify a protein-coding region in a eukaryotic genome?

   a) Look for a continuous sequence that codes for the full-length protein.
   b) Look for open reading frames.
   c) Compare the DNA sequence with known mRNA sequences.
   d) Look for exon-intron boundaries in the genomic sequence.
   e) Look for start and stop codons.
17) The following is a diagram of a sequencing gel. **What was the sequence of the original DNA template read in the 5’ to 3’ direction?**

![Sequencing Gel Diagram]

a) 5’ACTCGATCGGAT3’.
b) 5’ATCCGATCGAGT3’
c) 5’TAGGCTAGCTCA3’
d) 5’TGAGCTAGCCTA3’.
e) None of the above

18) **Which of the following statements concerning ubiquitination is CORRECT?**

a) E1 and E2 proteins together form the ubiquitin ligase complex that binds to a degradation signal on the target protein.
b) Ubiquitin is attached to the ε-amino group on arginine side chains in the target protein.
c) Target proteins containing one molecule of ubiquitin are destroyed by the proteasome.
d) Kary Mullis won the Nobel prize for his early work on ubiquitination.
e) Ubiquitin ligase is sometimes activated upon phosphorylation by a protein kinase.
19) Which of the following statements concerning protein folding and degradation is CORRECT?

a) Hsp 70 binds to hydrophobic residues on proteins to aid protein folding.

b) The refolding of proteins by hsp 60 does not require energy.

c) In the process of ubiquitination of proteins, E1 and E3 form ubiquitin ligase.

d) Less than 5% of newly synthesized proteins are degraded by ubiquitination.

e) The function of E3 during the process of ubiquitination is to activate ubiquitin.

20) What is produced upon transcription and translation of the “bait” plasmid?

a) A fusion protein of the Gal4 activation domain and an unknown protein.

b) A fusion protein of the Gal4 DNA-binding domain and Gal4 activation domain.

c) A fusion protein of Gal4 with a protein of interest.

d) The amino acid histidine.

e) A fusion protein of the Gal4 DNA-binding domain and a protein of interest.
21) Here are the results of a ClustalW alignment. What does the “:” found at the bottom represent?

<table>
<thead>
<tr>
<th></th>
<th>HumanViol</th>
<th>YLFK------NISVGPWDGPQYHIAPVWAFYL 44</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mystery</td>
<td>LLFK------NISLVPGPWDGPQYHLAPVWAFHL 45</td>
<td></td>
</tr>
<tr>
<td>ChickViol</td>
<td>YLFT------NGSVPGPWDGPQYHIAPVWAFHL 42</td>
<td></td>
</tr>
<tr>
<td>GoldfishUV</td>
<td>YQFG------NLSKISPFGPQYHLAPWAFYL 40</td>
<td></td>
</tr>
<tr>
<td>ChickBlue</td>
<td>YIPMALDAPNITALSPLVFQTHLGPGLFRA 54</td>
<td></td>
</tr>
<tr>
<td>ChickRed</td>
<td>RDSVFYTNSNNTRGPGPNYHAPRWWYNL 60</td>
<td></td>
</tr>
</tbody>
</table>

Residues that are:

a) conserved. They all have the same property.

b) semi-conserved. Some of them share the same property.

c) semi-conserved. They all have the same property.

d) identical.

e) conserved. Some of them share the same property.

22) Use the information in question #21. For the portion of the sequences shown, what is the sequence identity between ChickBlue and ChickRed?

a) 2%

b) 10%

c) 12.5%

d) 25%

e) Impossible to calculate
23) A fusion protein consisting of GFP and the full-length glucocorticoid receptor was expressed in cells. Half of the cells were incubated with glucocorticoids (condition 1) and the other half of the cells were not treated with the hormone (condition 2). What would you expect to observe?

a) Condition 1: fluorescence observed throughout the cell; Condition 2: fluorescence observed in the nucleus alone.

b) Condition 1: fluorescence observed only in the cytoplasm; Condition 2: fluorescence observed in the nucleus alone.

c) Condition 1: fluorescence observed only in nucleus; Condition 2: fluorescence observed throughout the cell.

d) Condition 1: fluorescence observed throughout the cell; Condition 2: fluorescence observed throughout the cell.

e) Condition 1: fluorescence observed only in the nucleus; Condition 2: fluorescence observed only in the cytoplasm.

24) The mystery sequence identified in lectures was bovine (cow) opsin. Which of the following describes the BEST experiment that could be performed to determine if cows express the gene?

a) Isolate genomic DNA from bovine skin cells, cut it with a restriction enzyme, run it on a gel, blot and probe with bovine DNA specific for the coding sequence of bovine opsin.

b) Isolate RNA from bovine skin cells, cut it with a restriction enzyme, run it on a gel, blot and probe with bovine DNA specific for the coding sequence of bovine opsin.

c) Isolate RNA from bovine skin cells, run it on a gel, blot and probe with bovine DNA specific for the promoter sequence of bovine opsin.

d) Isolate RNA from many types of bovine tissue, run the samples on a gel, blot and probe with bovine DNA specific for the coding sequence of bovine opsin.

e) Isolate genomic DNA from several animals, including cows. Cut the genomic DNA with restriction enzymes, run the DNA samples on a gel, blot and probe with the bovine opsin gene.
25) In lectures, you learnt that a metabolite can regulate the synthesis of mRNA coding for enzymes used to make the metabolite. You were shown the following diagram. Predict what would happen if the DNA sequence coding for region 4 was altered so that region 3 and 4 could no longer base pair.

Note that X represents a metabolite.

a) Regions 2 and 3 would base pair and a transcription termination signal would still be present.

b) The levels of mRNA coding for the enzymes to make metabolite X would be lower than those found in a normal cell.

c) A greater concentration of metabolite X would be found in the cell in comparison to a normal cell.

d) Translation of the mRNA sequence would be blocked because of the binding of metabolite X.

e) The binding of RNA polymerase to the promoter region would be enhanced because of the mutation.

26) Which of the following is found in BOTH the primary transcript and in mature mRNA in eukaryotes?

a) All of the introns.

b) The branch point A.

c) The promoter region.

d) A poly A tail.

e) A 5’ cap.
27) Which of the following concerning prokaryotic transcription is CORRECT?

a) Sigma factor 70 binds to two places in the promoter region.

b) RNA polymerase becomes processive when transcription terminates.

c) Promoters that bind sigma factor 70 also bind other types of sigma factors.

d) RNA polymerase requires a primer before it can function.

e) A full-length prokaryotic transcript must be made before protein synthesis can begin.

28) A single nucleotide is inserted into the 5' end of exon 1 of a gene. What is the consequence of this change?

a) It is possible that translation would not occur normally because the start codon would be mutated.

b) It is unlikely that the gene would be transcribed.

c) An mRNA one nucleotide shorter than normal would be made.

d) The protein produced from the mutated mRNA would be the same as the protein produced from the normal.

e) An mRNA much longer than normal would be made because splicing would not occur properly.

29) The following is a sequence of DNA that you would like to amplify by PCR. Which of the following sets of primers could be used to amplify this region? (Assume that primers 15 bp or more in length are OK.)

5’ ACTTACC GGTTACT ACCCCTTTG AGGGAT CCCTAGCCTATATTACCTCGG3’

3’ TGAATGGCAATGATGGGGAAACTCCCTAGGATCGGATATAATGGAGCC5’

a) Forward: 5’ACTTACC GGTTACT AC3’; Reverse: 5’CCGAGGTAATATAGG3’

b) Forward: 5’TGAATGGCAATGATG3’; Reverse: 5’GGCTCCATTATATCC3’

c) Forward: 5’ACCTTACC GGTTACT AC3’; Reverse: 5’GGCTCCATTATATCC3’

d) Forward: 5’GGTAGTAACGGGTAA3’; Reverse: 5’ATCGGATATAATGGAG3’

e) None of the above.
30) Why are antibiotic resistance genes included in plasmid vectors?
   a) To kill bacteria that contain plasmids with no DNA insert.
   b) So that the plasmids have an origin and can replicate.
   c) To ensure that the plasmids in the bacteria have a DNA of interest.
   d) To select for bacteria that contain plasmids.
   e) To allow the bacterial cells to grow in medium without histidine.

31) Which of the following statements concerning translation is CORRECT?
   a) EF-Tu binds directly to the start codon.
   b) EF-Tu is active when it is bound to GTP.
   c) Release factors are made of tRNA and recognize stop codons.
   d) EF-Tu and EF-G are used in eukaryotes.
   e) A ribosomal protein provides the enzymatic activity of peptidyltransferase.

32) Which of the following is NOT a step in a binding site selection assay?
   a) Compare the sequences obtained to look for regions of similarity.
   b) Label random oligonucleotides with radioactivity.
   c) Incubate oligonucleotides with a cell lysate containing a mix of proteins.
   d) Run the oligonucleotides out on an agarose gel.
   e) Clone selected oligonucleotides into plasmids.
33) In promoter analysis, what is the function of the minimal promoter in these experiments?

a) It is the site to which the origin binding proteins bind so that the DNA can be replicated.

b) It is the site to which the general transcription factors bind.

c) It is the site to which histone acetylases bind to acetylated histones.

d) It is the site to which activator proteins bind to enhance transcription.

e) None of the above.

34) A ligand binds to a gene regulatory protein causing the protein to bind to a DNA element and inhibit transcription. What is the name of this type of ligand and what is this process called?

a) Ligand = inducer; Process = derepression

b) Ligand = inactivator; Process = deactivation

c) Ligand = inducer; Process = co-repression

d) Ligand = repressor; Process = repression

e) Ligand = co-repressor; Process = co-repression

35) If the region of DNA immediately upstream from the lac promoter was mutated so that the catabolite activator protein was able to bind to DNA even in the absence of cAMP, what would you expect to see in bacteria carrying this mutation?

a) RNA polymerase would not be able to bind to the lac promoter.

b) The lac repressor in the presence of allolactose would bind to the lac operator.

c) The bacteria would have difficulty growing in medium containing only lactose.

d) Positive regulation of the lac operon would occur normally.

e) In glucose and lactose, β-galactosidase levels would be greater than normal.
36) Which of the following statements is CORRECT?

a) Eukaryotic gene activator proteins tend to be modular in structure, comprised of a DNA binding domain and an RNA polymerase enzymatic domain.

b) Eukaryotic gene repressor proteins bind histone acetylases via their repressor domains.

c) Eukaryotic transcriptional activator proteins must bind very close to promoters that they influence.

d) A given gene regulatory protein acts as either an activator or a repressor and can never have both functions.

e) Eukaryotic transcriptional repressor proteins can block the activation domain on a transcriptional activator protein.

37) What happens at the trp operon when the levels of the amino acid tryptophan are low?

a) Tryptophan binds to the trp repressor and prevents it from binding to DNA.

b) A polycistronic mRNA coding for a protein with many tryptophan residues is made.

c) The trp repressor is bound to the operator of the trp operon.

d) Catabolite activating protein (CAP) binds to a site upstream of the promoter.

e) Five individual mRNAs are produced each coding for an enzyme required to make tryptophan.

38) Which of the following concerning the initiation phase of translation in eukaryotes is CORRECT?

a) eIF-4E provides energy for the movement of the small ribosomal subunit to the AUG codon.

b) An aminoacyl-tRNA must be bound to the E site of the ribosome to start translation.

c) e-IF-2 brings the initiator aminoacyl-tRNA to the P site.

d) EF-G binds to the initiator tRNA and the small ribosomal subunit.

e) eIF-2 bound to the poly A tail helps in the binding of mRNA to the small ribosomal subunit.
39) Which of the following is a feature of phytochromes?
   a) In plants, there is one gene coding for all phytochromes.
   b) Phytochromes are transported to the nucleus in the dark.
   c) In the cell, phytochromes bind to GFP and fluoresce.
   d) Phytochromes function as heterodimers.
   e) Phytochromes activate several genes involved in photomorphogenesis.

40) What is observed in plants with non-functional COP1 proteins?
   a) Light-activated gene expression is observed only in the dark.
   b) Light-activated gene expression is repressed in the light.
   c) There are no differences in gene expression in comparison to normal plants.
   d) Light-activated gene expression is observed in the light and in the dark.
   e) None of the above.

41) Which of the following statements concerning sex determination in *Drosophila* is CORRECT?
   a) The default pathway in which there is no regulation of splicing is in females.
   b) The Y chromosome codes for a gene that directs development of a male fly.
   c) A functional Sxl protein is made in embryos with an X:A ratio of 0.5.
   d) Sxl protein blocks a splice site on the *tra* primary RNA transcript.
   e) The function of Dsx protein in males is to activate male differentiation genes.
42) You would like to construct a plasmid cloning vector that will express human β-globin in bacterial cells. What pieces of DNA or sequences from the following list would you need to construct the cloning vector? Give a complete list.

(1) A eukaryotic promoter.
(2) DNA sequence coding for β-globin protein.
(3) DNA coding for a Shine-Dalgarno sequence.
(4) A prokaryotic promoter.
(5) An origin of replication.
(6) The gene regulatory region for β-globin protein.
(7) A Kozak sequence.

a) 1, 2, 5, 6, 7
b) 2, 3, 4, 5
c) 1, 2, 3, 7
d) 2, 3, 4, 6
e) 1, 6

43) Which of the following statements about the regulation of translation is CORRECT?

a) Translation starts from all AUG codons found in a given mRNA.
b) The 3’ UTR of the mouse CTN mRNA is required for the synthesis of CTN in the cytoplasm.
c) Phosphorylation of eIF-4G inhibits translation of all mRNA in the cell.
d) Proteins that bind to the 5’ and 3’ UTR can negatively regulate translation.
e) Internal ribosome entry sites (IRES) are regions in ribosomal proteins that bind to eIF factors.
44) Which of the following statements is CORRECT?

a) RNA interference is found exclusively in plant cells.

b) Dicer is a complex that has RNase activity and cleaves single-stranded RNA.

c) Virus-induced gene silencing is used as a defence mechanism in plants.

d) RNA interference is an interesting biological process, but it has no utility in the laboratory.

e) In RNA interference, double-stranded RNA fragments of 100 bp in length are produced.

45) Retroviruses such as human immunodeficiency virus have which of the following characteristics?

a) They are surrounded by a protein capsid, but no envelope.

b) They contain RNA that is immediately translated when the nucleic acid enters the cell.

c) The virus is packaged with virally encoded reverse transcriptase.

d) The function of reverse transcriptase is to make an RNA copy of viral DNA.

e) One of the proteins coded by the virus has RNA polymerase activity.

46) Which of the following concerning bacterial chromosomes is CORRECT?

a) Bacterial genomes consist of one linear chromosome.

b) Bacterial chromosomes are condensed by negatively charged polyamines.

c) Bacterial chromosomes are more condensed in comparison to eukaryotic genomes, because bacterial cells are small.

d) Supercoiling of bacterial DNA helps to pack bacterial chromosomes into cells.

e) Another name for a bacterial chromosome is a plasmid.
47) Which of the following are features of X chromosome inactivation?

a) XIST RNA induces euchromatin formation.

b) Hyperacetylation of histones associated with the X chromosome.

c) Translation of XIST RNA into XIST proteins that coat the chromosome.

d) In females, the paternal X chromosome inactivated in all cells.

e) Production of XIST RNA from the X-inactivation centre.

48) What would you expect to observe in two separate samples of complementary DNA (cDNA), one made from mRNA isolated from liver and the other made from mRNA isolated from brain? (Assume that primers consisting of deoxythymidylate were used for cDNA synthesis.)

a) Neither sample would have DNA that contained long stretches of deoxyadenylate.

b) Fragments of DNA greater than one million base pairs in length would be common.

c) Both samples of DNA would contain many DNA sequences that were homologous to genomic intron sequences.

d) This would be a method to isolate the gene regulatory regions used by activators and repressors that were unique to each tissue.

e) Many of the DNA sequences would be the same in both samples, but there would be others that were only found in one of the two samples.
49) Assume a scientist has isolated the entire gene regulatory region for the gene coding for protein X. She ligated the regulatory region to DNA coding for green fluorescent protein (GFP). She then injected single-celled mouse embryos with the DNA such that the DNA became incorporated into a chromosome in the nucleus and all cells in the mice that were born carried the DNA. **What would she expect to observe?**

a) The mice would not develop properly and would die before birth.

b) All of the cells in the mice that were born would fluoresce.

c) Only the cells that usually express protein X would fluoresce.

d) In the cells that express GFP protein, only the nucleus would fluoresce.

e) The fluorescence would localize to the same region of cells that protein X is normally found.

50) **Which of the following statements concerning the yeast two-hybrid assay is CORRECT?**

a) A disadvantage of the assay is that it can not be scaled up to examine the many protein interactions at one time.

b) A disadvantage of the assay is that labour intensive methods are required to purify and identify the prey proteins from yeast cells.

c) A disadvantage of the assay is that false positives can occur such as the false positive that would be observed if the bait protein had an activation domain.

d) An advantage of the assay is that no further experiments are required once the interaction is identified by the assay.

e) An advantage of the assay is that protein interactions always take place without post-translational modifications so it does not matter if yeast cells are used.
51) The following picture represents the volume setting of a P200 micropipettor. **What volume of fluid will be delivered if the pipettor is used correctly?**

   | 1 |
   | 4 |
   | 5 |

a) 1450 µl  
b) 145 µl  
c) 14.5 µl  
d) 14.5 ml  
e) 1.45 µl

52) **Which of the following procedures will INCREASE the yield of DNA during DNA isolation?**

   a) Use of chloroform-isoamyl alcohol to denature proteins and to facilitate aqueous and organic phasing.  
b) Replacing sodium chloride with potassium acetate in the DNA isolation buffer.  
c) Adding 2 volumes of ice-cold butanol (2 part butanol: 1 part DNA) to precipitate DNA from solution.  
d) Performing the entire DNA isolation experiment at 37°C.  
e) None of the above.
53) Which of the following statements concerning DNA isolation is CORRECT?

a) Chloroform-isoamyl alcohol exposes the internal hydrophilic environment of proteins to their exterior water environment.

b) Water will preferentially form hydrogen bonds with alcohol instead of DNA because it results in higher entropy.

c) UV spectroscopy at 280 nm can be used to measure the concentration of DNA.

d) EDTA prevents enzymatic degradation of DNA through inhibition of the active binding site of nucleases.

e) In prokaryotes, the association of DNA with histones can be disrupted by using high salt concentration.

54) What is the purpose of having a high NaCl concentration when isolating RNA?

a) None, high salt concentration will degrade RNA.

b) It chelates RNases and prevents them from digesting RNA.

c) It is used to help precipitate RNA.

d) It solubilizes the plasma membrane.

e) Both b and d

55) What are the most common sizes of rRNA visualized when isolating RNA?

a) 30S and 18S

b) 23S and 16S

c) 23S and 5S

d) 23S, 5S and 16S

e) None of the above.
56) Which of the following sequences would be considered a palindromic sequence when in double-stranded DNA?

a) 5'ATCTA3'

b) 5'AAATTT3'

c) 5'CGCGC3'

d) 5'GCATTT3'

e) Both a and c

57) Which of the following is NOT a function of the loading dye that was added to your restriction enzyme digest?

a) To allow the DNA to be visualized with UV light.

b) To give the sample some density so that it drops into the well.

c) To stop the restriction enzymatic reaction.

d) To visualize the sample while loading.

e) To check how far the sample has moved on a gel during electrophoresis.

58) What is the functional significance of the major groove in DNA?

a) The major groove is present when DNA is being replicated.

b) There is not much functional significance, as DNA must be unwound to obtain information.

c) It is recognized by DNA-binding proteins, such as activators and repressors.

d) The major groove is the site where the small ribosomal subunit binds.

e) There is not much functional significance, as the structure of the DNA along the major groove is constant.
59) The alpha helix is an example of what type of protein structure?

a) Primary  
b) Secondary  
c) Tertiary  
d) Quaternary  
e) A functional domain

60) When studying the three-dimensional structure of proteins, why is it necessary to crystallize proteins prior to applying a beam of X-rays?

a) Crystalline proteins emit more radiation and nuclear magnetic resonance, thereby causing a spectral shift so that the distance between atoms can be determined.  
b) Protein crystals have a regular structure allowing all X-rays to pass through to the detector without interference.  
c) X-rays have a very short wavelength and will not pass through liquid protein samples.  
d) Single molecules of protein would not scatter enough X-rays to detect diffraction spots.  
e) The synchrotron used to produce high energy X-rays would become plugged if liquid protein samples were used.

61) What is meant when a protein is described as amphipathic?

a) It means that the protein consists only of β-sheets.  
b) It contains lipid and carbohydrate.  
c) It has a secondary structure.  
d) It is in a complex consisting of more than one polypeptide chain.  
e) It has both hydrophobic and hydrophilic parts.
62) **What is a function of lysozyme?**
   
a) It destroys the viral capsid protein and is therefore antiviral.

b) It breaks down the nuclear membrane in bacteria and is therefore antibacterial.

c) It is used for the synthesis of lactose in bacterial cells.

d) It destroys DNA, allowing for the purification of RNA.

e) It is used for isolating RNA from bacteria because it breaks down cell walls.

63) You have been asked to build a model of guanosine and cytidine. **Which of the following is CORRECT?**
   
a) The models represent the basic subunits of DNA.

b) You would need to get two pieces representing atoms of phosphorus.

c) You would require more pieces to make guanosine compared with cytidine.

d) The sugar in your model would have a hydrogen on the C2’ atom.

e) You would attach the base to the C5’ atom.

64) You have been asked to make 250 ml of a 200 mM solution of NaOH. The molecular weight of NaOH is 40 g. **How many grams of NaOH do you need dissolve in water and make up to a final volume of 250 ml?**
   
a) 1 g

b) 2 g

c) 4 g

d) 8 g

e) 40 g
65) A 25 kb linear piece of DNA was cut with the following restriction enzymes \textit{HindIII} and \textit{BamH1}.

\textit{BamH1}: 4Kb, 21Kb  \\
\textit{HindIII}: 6Kb, 9Kb, 10Kb  \\
\textit{HindIII} + \textit{BamH1}: 4Kb, 5Kb, 6Kb, 10Kb

Which of the following is the CORRECT restriction map?

\begin{itemize}
  \item [a)] \hspace{1cm} \begin{tabular}{c|c|c|c}
    \textit{BamH1} & \textit{HindIII} & \textit{HindIII} \\
    4Kb & 5Kb & 10Kb & 6Kb
  \end{tabular}
  \\
  \item [b)] \hspace{1cm} \begin{tabular}{c|c|c|c}
    \textit{HindIII} & \textit{BamH1} & \textit{BamH1} \\
    10Kb & 4Kb & 6Kb & 5Kb
  \end{tabular}
  \\
  \item [c)] \hspace{1cm} \begin{tabular}{c|c|c|c}
    \textit{BamH1} & \textit{HindIII} & \textit{HindIII} \\
    4Kb & 5Kb & 6Kb & 10Kb
  \end{tabular}
  \\
  \item [d)] \hspace{1cm} \begin{tabular}{c|c|c|c}
    \textit{BamH1} & \textit{HindIII} & \textit{BamH1} \\
    4Kb & 5Kb & 6Kb & 10Kb
  \end{tabular}
\end{itemize}

\textbf{e) Both a and c are possible}
66) Which type of RNA migrates the furthest from the well when RNA extracted from prokaryotes is run on an agarose gel?

a) tRNA.

b) all of the mRNA.

c) 23S rRNA.

d) 16S rRNA.

e) 5S rRNA.

67) Which of the following would you add to a tube containing bacterial DNA if you wanted to make many copies of a portion of the 16S rRNA gene using PCR?

a) dNTPs, lysozyme, buffer with Mg$^{2+}$, RNA primers, and water

b) ddNTPs, DNA polymerase, buffer with Mg$^{2+}$, DNA primers, and water

c) dNTPs, DNA polymerase, buffer with Mg$^{2+}$, DNA primers, and water

d) dNTPs, DNA polymerase, buffer with Mg$^{2+}$, RNA primers, and water

e) dNTPs, reverse transcriptase, buffer with Mg$^{2+}$, DNA primers, and water

68) Which of the following statements concerning the E-value is CORRECT?

a) The E-value is not related to the size of the database and therefore, for a given sequence, will not change as sequences are added to the database.

b) The higher the E-value, the more significant the Score.

c) The E-value is completely independent from the Score and is calculated using probabilities.

d) The E-value tells you the expected Score that could occur when searching a database of a given size.

e) The E-value tells you the number of matches with Scores equivalent to or better than a given Score that could occur in a database search by chance.
69) In the GenBank record of a BLAST search, the Accession number

a) indicates the base pair where transcription begins.

b) indicates the organism from whence the DNA originated.

c) is the similarity between one sequence and another.

d) is a unique code that is assigned to each entry.

e) is the probability that one sequence is the same as another.

70) You sequence genomic DNA from a novel bacterium and discover that the nucleotide sequence of the gene coding for the lac repressor protein differs from normal. You then grow the mutant bacteria and normal bacteria in different media and find that the mutant bacteria are not able to grow in medium containing lactose alone. **What is a possible explanation for your observations?**

a) The mutant lac repressor protein binds more strongly than normal to allolactose.

b) With or without lactose, the mutant lac repressor protein is not able to bind to the lac operator.

c) The binding site for allolactose on the mutant lac repressor protein is defective and allolactose can not bind.

d) The lac repressor protein can no longer recruit co-activators like histone deacetylases to the *lac* operon.

e) The mutant lac repressor protein is no longer able to bind to the CAP binding site on the *lac* operon.

71) Which of the following is the BEST method to study the function of specific regions of a eukaryotic promoter?

a) Southern blot.

b) Fluorescence *in situ* hybridization.

c) Western blot.

d) Experiments using reporter genes.

e) Northern blot.
72) A bacterial strain does not grow well in low levels of tryptophan. **What could be wrong with the bacterium?**

There is a mutation in the

a) repressor so that it does not bind to the operator.

b) CAP binding site so that CAP can not bind.

c) E gene of the trp operon.

d) repressor so that it does not bind to tryptophan.

e) None of the above.

73) **Which of the following is a function of bacterial 16S rRNA?**

a) It is required to help the ribosome translocate along the mRNA during translation.

b) It binds to e1F-2 to help position the initiator tRNA at the P site on the small subunit of the ribosome.

c) It has enzymatic activity and is responsible for catalyzing peptide bond formation during translation.

d) It contains a sequence that is complementary to the 3’ end of mRNA to help in recognizing release factors at the end of translation.

e) It contains a sequence that is complementary to the 5' end of mRNA to help position the mRNA on the ribosome.

74) **In a PCR reaction, what is the purpose of the negative control?**

a) To amplify a fragment of DNA from a sample of pure DNA.

b) To ensure that the DNA polymerase is active.

c) To ensure that components of the PCR reaction are not contaminated with DNA.

d) To ensure that the primers work.

e) To amplify a fragment of DNA from a mixture of DNA.
75) Which of the following amino acids contains an OH group in its side chain?

a) H  
b) S  
c) K  
d) F  
e) C

END OF TEST