Bio 351 Molecular and Cellular Biology

Final Exam

Multiple Choice Questions (1 point each). Each blank is also 1 point each; Total points: 75

9 Which of the following would you NOT expect to find in a bacterial cell?

A. Swimming using flagella

B. Having a cell wall around the plasma membrane

C. ATP production in mitochondria

D. Protein production on the ribosome

E. Sexual exchange of DNA with other bacteria

10 To trace family relationships between distantly related organisms such as humans, algae, bacteria, and archaea, one should compare their genomes in regions …

A. that evolve rapidly.

B. that have a higher mutation rate.

C. that code for proteins.

D. where mutations are hardly tolerated.

E. where most mutations are selectively neutral.

10 Laboratory strains of the model organism *Escherichia coli* that are resistant to antibiotics are very often used in research laboratories as well as in the biotechnology industry. If cultures of such bacteria were allowed to contaminate the environment uncontrollably, it is possible that at some point, pathogenic bacteria such as *Neisseria meningitidis* (which causes meningitis and can cause death, especially in children) could acquire the same antibiotic-resistance gene, causing a meningitis outbreak that is difficult to treat. In this scenario, which of the following mechanisms is a more likely source of the antibiotic-resistance gene in *N. meningitidis*?

A. Random new gene generation

B. Intragenic mutation

C. Gene duplication

D. DNA segment shuffling

E. Horizontal gene transfer

10 A virus …

A. is a type of cell.

B. has genetic material made of proteins.

C. can only infect a single host species.

D. can act as a vector for gene transfer.

E. cannot persist in its host for more than one cell generation.

10 Which of the following does NOT typically involve horizontal gene transfer?

A. Sexual reproduction in humans

B. Bacteriophage infection of bacteria

C. The evolutionary history of the eukaryotic cell

D. The accidental duplication of a small region of a bacterial chromosome followed by cell division

E. Introduction of plasmids into bacteria in a laboratory

1 Which of the following statements is true regarding cellular metabolism?

A. A living organism decreases the entropy in its surroundings.

B. During catabolism, heat is generated, and the cell uses this heat to perform work during anabolism.

C. The heat released by an animal cell as part of its metabolic processes comes from the bond energies in the foodstuffs that are consumed by the animal.

D. Living organisms defy the second law of thermodynamics, but still obey the first law.

1 Which of the following correctly summarizes the overall process of photosynthesis?

A. $CO_2 + O_2 \rightarrow H_2O$ + sugars

B. $CH_2O + CO_2 + O_2 \rightarrow H_2O$ + sugars

C. $CO_2 + H_2O \rightarrow H_2 + CO_2$

D. $CO_2 + H_2O \rightarrow O_2$ + sugars

1 Which of the following statements is true regarding reactions involving oxidation and reduction?

A. The carbon atom is more oxidized in formaldehyde (CH_2O) than in methanol (CH_3OH).

B. Oxidation of food in all organisms requires oxygen.

C. A molecule is oxidized if it gains an electron (plus a proton) in a reaction.

D. A dehydrogenation reaction is a reduction.

E. In an organic molecule, the number of C–H bonds increases as a result of oxidation.

1 Enzymes are the cell's catalyst crew. They make the life of the cell possible by carrying out various reactions with astounding performance. Which of the following is NOT true regarding cellular enzymes?

A. Enzymes lower the activation energy of the reactions that they catalyze.

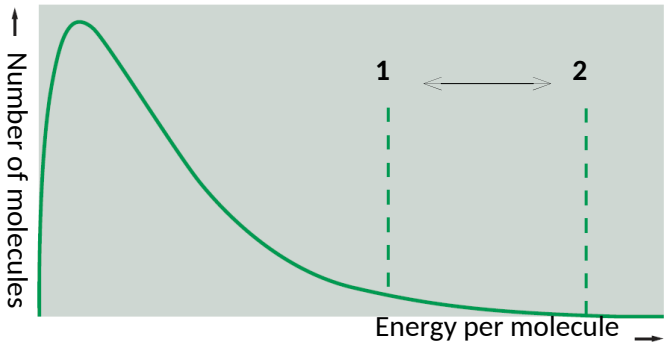
B. Enzymes can specifically drive substrate along certain reaction pathways.

C. Enzymes can push energetically unfavorable reactions forward by coupling them to energetically favorable reactions.

D. Enzymes are proteins, but RNA catalysts, called ribozymes, also exist.

E. Enzymes can change the equilibrium point for reactions that they catalyze.

1 In the following diagram showing the distribution of thermal energy in a population of substrate molecules, the energy thresholds indicated by numbers represent ...



A. the activation energy at high and low temperature.

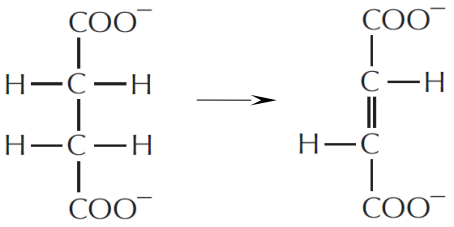
B. the reaction rate at high and low pH.

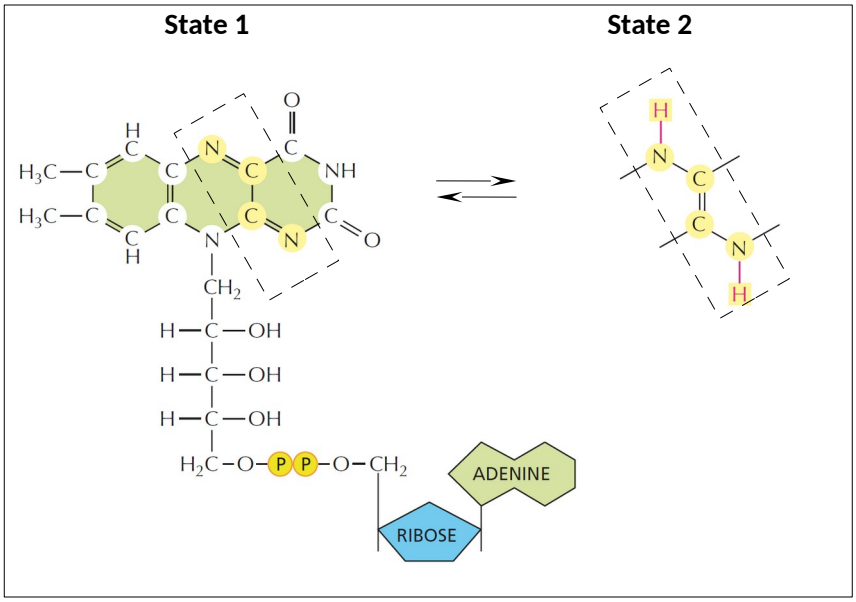
C. the activation energy with and without an enzyme.

D. the reaction rate at high and low substrate concentrations.

E. the activation energy at high and low substrate concentrations.

1 A cellular enzyme catalyzes the catabolic reaction shown below. Its coenzyme is shown in the box. Which of the following is correct regarding this reaction?





A. The substrate is reduced in this reaction and the coenzyme is converted from state 1 to state 2.

B. The substrate is oxidized in this reaction and the coenzyme is converted from state 1 to state 2.

C. The substrate is reduced in this reaction and the coenzyme is converted from state 2 to state 1.

D. The substrate is oxidized in this reaction and the coenzyme is converted from state 2 to state 1.

1 Sort the following molecules from a low to high rate of diffusion inside the cytosol. Your answer would be a four-letter string composed of letters A to D only, e.g. ADCB.

(A) Myoglobin (a protein)

(B) Glycine (an amino acid)

(C) Ribosome (a protein–RNA complex)

(D) CO_2

1 Imagine the reaction A → B with a negative Δ*G* value under experimental conditions. Which of the following statements is true about this reaction?

A. The reaction is energetically unfavorable.

B. The reaction proceeds spontaneously and rapidly under these conditions.

C. Increasing the concentration of B molecules would increase the Δ*G* value (toward more positive values).

D. The reaction would result in a net decrease in the entropy (disorder) of the universe.

E. The reaction cannot proceed unless it is coupled to another reaction with a positive value of Δ*G*.

1 Which of the following pairs of amino acid residues would you expect to form ionic bonds?

A. Glutamic acid and glutamine

B. Arginine and lysine

C. Lysine and glutamic acid

D. Tryptophan and tyrosine

E. Tyrosine and glutamine

1 Which of the following is NOT the role of molecular chaperones in the folding of cellular proteins?

A. They assist proteins in folding into their correct conformations.

B. They help prevent formation of protein aggregates.

C. They specify the final three-dimensional shape of proteins.

D. They catalyze the folding of proteins in the crowded environment of the cell.

E. They make the protein-folding process in the cell more reliable.

1 The observation that proteins often *renature* into their original conformations after they have been unfolded by denaturing solvents implies that …

A. the information needed to specify the three-dimensional shape of a protein is encoded in its amino acid sequence.

B. the cell does not need molecular chaperones for survival.

C. the final folded structure of a protein is usually NOT the one with the lowest free energy.

D. each protein folds into several different conformations inside the cell.

E. All of the above.

1 Protein secondary structure elements such as α helices and β sheets constitute the major regular folding patterns in proteins. With regard to these elements, …

A. hydrogen-bonding between the amino acid side chains defines the type of secondary structure.

B. a certain short amino acid sequence always adopts the same secondary structure.

C. only a few specific amino acid sequences can adopt these repetitive structures.

D. the folding patterns result from hydrogen-bonding between the N–H and C=O groups in the polypeptide backbone.

E. All of the above.

1 Which of the following is NOT true regarding the members of a protein family in general?

A. They have similar three-dimensional conformations.

B. They share an ancestry; i.e. they are homologs.

C. They can functionally replace each other.

D. Their gene sequence is less well conserved than their structure.

E. Over evolutionary time scales, the family has expanded mainly through gene duplication events.

1 The human estrogen receptor is a symmetrical dimeric nuclear protein that can regulate gene expression by binding to a DNA sequence called an estrogen response element (ERE) near the promoter of its target genes. Each subunit of the receptor binds to about six base pairs of DNA. Which of the following sequences is a likely candidate for the ERE? The sequences are written in the 5′-to-3′ direction. The letter N represents any of the four DNA bases.

A. AGGTCANNNTGACCT

B. AGGTCANNNAGGTCA

C. AGGTCANNNACTGGA

D. AGGTCANNNATATAT

E. AGGCCTNNNTCATGA

1 Which of the following can be a function for intrinsically disordered protein sequences?

A. High-specificity binding to other proteins

B. Cell signaling through covalent modification of the protein sequence

C. Tethering to hold interacting proteins in close proximity

D. Formation of a diffusion barrier from a dense network of such sequences

E. All of the above

1 Which of the following features of DNA underlies its simple replication procedure?

A. The fact that it is composed of only four different types of bases

B. The antiparallel arrangement of the double helix

C. The complementary relationship in the double helix

D. The fact that there is a major groove and a minor groove in the double helix

1 Which of the following correlates the best with biological complexity in eukaryotes?

A. Number of genes per chromosome

B. Number of chromosomes

C. Number of genes

D. Genome size (number of nucleotide pairs)

1 The eukaryotic chromosomes are organized inside the nucleus with a huge compaction ratio of several-thousand-fold. What is responsible for such a tight packaging?

A. The various chromatin proteins that wrap and fold the DNA

B. The nuclear envelope which encapsulates the chromosomes

C. The nuclear matrix that provides a firm scaffold

D. All of the above

1 The two chromosomes in each of the 22 homologous pairs in our cells ...

A. have the exact same DNA sequence.

B. are derived from one of our parents.

C. show identical banding patterns after Giemsa staining.

D. usually bear different sets of genes.

E. All of the above.

1 Compared to the human genome, the genome of yeast typically has …

A. more repetitive DNA.

B. longer genes.

C. more introns.

D. longer chromosomes.

E. a higher fraction of coding DNA.

1 It has been shown that inhibition of a key chromatin remodeling complex known as NuRD, by deleting one of its subunits, can result in a significant increase in the efficiency of reprogramming of somatic cells into pluripotent stem cells. The reprogramming is normally done by the induced expression of a battery of transcription factors in the somatic cells, but is typically not very efficient. Such an observation suggests that the NuRD complex is normally involved in …

A. erasing the epigenetic memory in somatic cells.

B. maintaining the epigenetic memory in somatic cells.

C. preventing DNA replication.

D. formation of extended loops from chromosome territories.

1 The mutation rate in bacteria is about 3 nucleotide changes per 10 billion nucleotides per cell generation. Under laboratory conditions, bacteria such as *Escherichia coli* can divide and double in number about every 40 minutes. If a single *Escherichia coli* cell is allowed to exponentially divide for 10 hours in this manner, how many mutations would you expect to observe on average in the genome (4.5 million nucleotide pairs) of each of the resulting bacteria compared to the original cell? Assume all mutations are neutral; that is, they do not affect the cell-division time.

A. Less than 0.001

B. About 0.02

C. One or two

D. About 10

E. About 100

1 On average, errors occur in DNA synthesis only once in every ten billion nucleotides incorporated. Which of the following does NOT contribute to this high fidelity of DNA synthesis?

A. Complementary base-pairing between the nucleotides

B. “Tightening” of the DNA polymerase enzyme around its active site to ensure correct pairing before monomer incorporation

C. Exonucleolytic proofreading by the 3′-to-5′ exonuclease activity of the enzyme to correct mispairing even after monomer incorporation

D. A strand-directed mismatch repair system that detects and resolves mismatches soon after DNA replication

E. All of the above mechanisms DO contribute to the fidelity.

1 The nuclear DNA polymerases in human cells …

A. polymerize about 1000 nucleotides per second during DNA replication *in vivo*.

B. are incapable of 3′-to-5′ exonuclease activity.

C. are capable of 3′-to-5′ DNA polymerase activity.

D. have a single active site that is used for both polymerization and editing.

E. are unable to initiate polymerization *de novo* (i.e. in the absence of a primer).

1 What is the main source of the free energy for the mechanical work performed by DNA helicases during DNA replication in our cells?

A. The hydrogen-bonding energy in the DNA double helix

B. Thermal energy in the nucleus

C. ATP hydrolysis by the helicase

D. The energy of SSB binding to single-stranded DNA

E. ATP hydrolysis by DNA topoisomerases

1 During DNA replication in the cell, DNA primase makes short primers that are then extended by the replicative DNA polymerases. These primers …

A. are made up of DNA.

B. generally have a higher number of mutations compared to their neighboring DNA.

C. are made more frequently in the leading strand than the lagging strand.

D. are joined to the neighboring DNA by DNA ligase.

E. provide a 3′-phosphate group for the DNA polymerases to extend.

1 DNA ligases are used in both DNA replication and repair to seal breaks in the DNA. But DNA damage can result in single- or double-strand breaks that are not normal ligase substrates. These need to be processed first before a ligase can act on them. One of the enzymes that is recruited to some of such breaks is called PNK. It has two separate activities on the DNA, both of which can help provide a canonical ligase substrate. Which of the following activities would you expect PNK to have in this context?

A. 5′ kinase (phosphorylation of a free 5′-OH group) and 3′ kinase

B. 5′ phosphatase (dephosphorylation to create a free 5′-OH group) and 3′ phosphatase

C. 3′ kinase and 3′ phosphatase

D. 5′ phosphatase and 3′ kinase

E. 5′ kinase and 3′ phosphatase

1 Which of the following is correct regarding the mutation rate of genomic DNA in different organisms?

A. Human cells have a much higher mutation rate compared to bacteria when the rate is normalized to a single round of replication over the same length of DNA.

B. Mutation rates limit the number of essential genes in an organism's genome.

C. Mutations in the somatic cells cannot be lethal.

D. Even if the mutation rate was 10 times higher than its current value, germ-cell stability in humans would not have been affected.

E. All of the above.

1 During DNA replication, the single-strand DNA-binding (SSB) proteins …

A. are generally found more on the leading strand than the lagging strand.

B. bind cooperatively to single-stranded DNA and cover the bases to prevent base-pairing.

C. prevent the folding of the single-stranded DNA.

D. bind cooperatively to short hairpin helices that readily form in the single-stranded DNA.

E. All of the above.

1 This protein is present at every replication fork and prevents DNA polymerase from dissociating, but does not impede the rapid movement of the enzyme. Which of the following is true regarding this protein?

A. It self-assembles onto DNA at the replication fork.

B. It is assembled on DNA as soon as DNA polymerase runs into a double-strand region of DNA.

C. Its assembly normally follows the synthesis of a new primer by the DNA primase.

D. It disassembles from DNA as soon as DNA polymerase runs into a double-strand region.

E. All of the above.

1 At the replication fork, the template for the lagging strand is thought to loop around. This looping would allow the lagging-strand polymerase to move along with the rest of the replication fork instead of in the opposite direction. The single-strand part of the loop is bound by the single-strand DNA-binding (SSB) proteins. As each Okazaki fragment is synthesized toward completion, how does the size of the loop change? What about the size of the SSB-bound part of the loop?

A. Increases; increases.

B. Increases; decreases.

C. Decreases; increases.

D. Decreases; decreases.

E. Decreases; does not change.

1 In *Escherichia coli*, replication of DNA can occur throughout the cell cycle while the cell is also actively transcribing its genes. This means collisions between replication forks and RNA polymerases are inevitable. Depending on the orientation of the genes, collisions can be rear-end (when both machines are traveling in the same direction) or head-on (when they are traveling in opposite directions). In the following paragraph, match each of the letters (A to D) to one appropriate number below. Do not use a number more than once. Your answer would be a four-digit number composed of digits 1 to 5 only, e.g. 1253.

> "Typically, in a rear-end collision, the (A) of RNA polymerase collides with the (B) in the replication fork. In contrast, in a head-on collision, the (C) of RNA polymerase hits the (D) in the fork."

1. front edge (of RNA polymerase)
2. rear edge (of RNA polymerase)
3. DNA helicase
4. leading-strand DNA polymerase
5. lagging-strand DNA polymerase

1 Which of the following features is common between the replication origins in *Escherichia coli* and *Saccharomyces cerevisiae*?

A. They both normally exist in one copy per genome.

B. Both are specified by DNA sequences of tens of thousands of nucleotide pairs.

C. Both contain sequences that attract initiator proteins, as well as stretches of DNA rich in A-T base pairs.

D. Both contain GATC repeats that are methylated to prevent the inappropriate "firing" of the origin.

E. All of the above.

1 You have found a strain of *Escherichia coli* that has an unusually short doubling time of only 15 minutes, despite the fact that its complete DNA replication should take almost 35 minutes. You also find that there is only one replication origin on its chromosome from which two forks originate, just like the normal process described for *E. coli*. However, you discover that the origin of replication in this strain has a significantly shorter "refractory period," resulting in the reactivation of the origin before the previous round of replication is over. Based on this model, if you examine the chromosomes of this

strain (under conditions of fast growth), how many replication forks would you expect to observe per chromosome on average?

A. Two, just like the wild-type strain

B. Four

C. Six

D. Eight

E. Ten

1 The telomerase enzyme in human cells …

A. has an RNA component.

B. extends the telomeres by its RNA polymerase activity.

C. polymerizes the telomeric DNA sequences without using any template.

D. removes telomeric DNA from the ends of the chromosomes.

E. creates the “end-replication” problem.

1 If this protein complex does not function normally, the ends of the eukaryotic chromosomes would activate the cell’s DNA damage response, causing chromosomal fusions and other genomic anomalies. What is this protein complex called?

A. Telomerase

B. T-loop

C. ORC

D. Shelterin

E. RecA

42. What do the enzymes topoisomerase I and topoisomerase II have in common?

A. They both have nuclease activity.

B. They both create double-strand DNA breaks.

C. They both require ATP hydrolysis for their function.

D. They both can create winding (tension) in an initially relaxed DNA molecule.

E. All of the above

43 What do the enzymes topoisomerase I and topoisomerase II have in common?

A. They both have nuclease activity.

B. They both create double-strand DNA breaks.

C. They both require ATP hydrolysis for their function.

D. They both can create winding (tension) in an initially relaxed DNA molecule.

E. All of the above.

44. What group of mobile genetic elements is largely responsible for the resistance of the modern strains of pathogenic bacteria to common antibiotics?

A. DNA-only transposons

B. Retroviral-like retrotransposons

C. Nonretroviral retrotransposons

D. Site-specific recombinases

45. DNA-only transposons …

A. can be recognized by the presence of short inverted repeats at each end.

B. often encode a transposase that mediates the transposition process.

C. leave double-strand breaks in the donor chromosome.

D. can move by a cut-and-paste mechanism.

E. All of the above

46. DNA and RNA polymerase differ in all of the following EXCEPT…

A. the nucleotide substrates they incorporate.

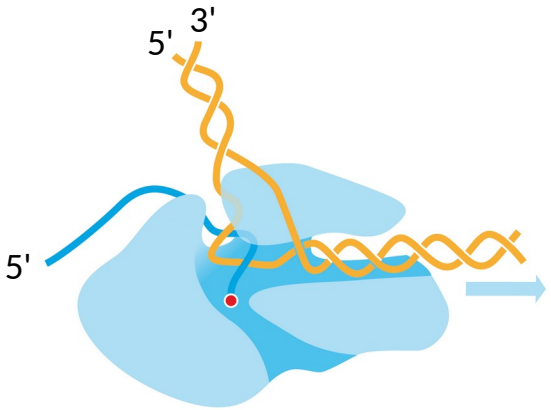
B. their requirement for a primer.

C. their error rate.

D. the type of chemical reaction they catalyze.

E. their processivity.

47. What enzyme is depicted in the following schematic drawing?



A. DNA polymerase

B. RNA polymerase

C. Ribosome

D. Reverse transcriptase

E. Topoisomerase

48. The sequence of a region of DNA around the 5′ end of a gene in *Escherichia coli* is shown below. The –10 hexamer and the transcription start site are highlighted. What would be the sequence of the first 10 nucleotides of the mRNA transcribed from this gene? Write down the sequence from 5′ to 3′, e.g. CGGAUAAACT.

5′…GCGCTTGG**TATAAT**CGCTGGG**G**GTCAAAGAT…3′

49. Due to their high transcription rate, active ribosomal RNA (rRNA) genes can be easily distinguished in electron micrographs of chromatin spreads. They have a characteristic “Christmas tree” appearance, where the DNA template is the “trunk” of the tree and the nascent RNA transcripts form closely packed “branches.” At the base of each branch is an RNA polymerase extending that branch, while RNA processing complexes at the tip of the branch form terminal “ornaments.” The top of the tree represents the … of the rRNA gene, and the “ornaments” are at the … end of the nascent rRNA molecules.

A. end; 3'

B. end; 5'

C. beginning; either 3' or 5'

D. beginning; 3'

E. beginning; 5'

50. Which of the following types of noncoding RNA chiefly functions in the processing and chemical modification of ribosomal RNAs (rRNAs)?

A. Small nuclear RNAs (snRNAs)

B. Small nucleolar RNAs (snoRNAs)

C. Small interfering RNAs (siRNAs)

D. Transfer RNAs (tRNAs)

E. MicroRNAs (miRNAs)

51. For the bacterial transcription machinery, which of the following mRNA sequences would you expect to constitute a potent transcriptional termination signal? Note that the two underlined regions in each sequence are complementary to each other.

A. 5'… UGGCCCAGUCGGAAGACUGGGCCUUUUGUUUU…3'

B. 5'… UGGCCCAGUCGGAAGACUGGGCCCGCGGAGCU…3'

C. 5'… UUUUGUUUUAGGCCCAGUCGGAAGACUGGGCCA…3'

D. 5'… CGCGGAGCUAGGCCCAGUCGGAAGACUGGGCCA…3'

52. The transcript for which of the following noncoding RNA in our cells is expected to undergo 5' cap addition after transcription?

A. 5S rRNA

B. miR-21 (a microRNA)

C. $tRNA^{Phe}$

D. 5.8S rRNA

E. 18S rRNA

53. This large and complex general transcription factor has a DNA helicase activity that exposes the template for RNA polymerase II transcription. It also has a kinase activity that phosphorylates the C-terminal domain of the polymerase on Ser5 leading to promoter clearance. It is…

A. TFIIB

B. TFIID

C. TFIIE

D. TFIIF

E. TFIIH

54. This general transcription factor recognizes the TATA box in RNA polymerase II promoters. It is…

A. the only single-subunit general transcription factor.

B. able to introduce a rather sharp kink in the double helix upon binding to DNA.

C. responsible for the phosphorylation of the RNA polymerase CTD during transcription initiation.

D. also responsible for the recognition of the BRE element in the promoter.

E. All of the above.

55. Of the following proteins or protein complexes, which one does NOT typically interact with an elongating RNA polymerase II?

A. Histone-modifying enzymes

B. Capping enzymes

C. Chromatin remodeling complexes

D. Mediator complex

E. Histone chaperones

56. How does a eukaryotic cell deal with the superhelical tension in its genomic DNA resulting from the activity of RNA polymerases?

A. DNA gyrase introduces negative supercoils, keeping the DNA under constant tension.

B. The RNA polymerases are allowed to rotate freely around their templates during transcription, leading to the relaxation of the tension.

C. DNA topoisomerases rapidly remove the superhelical tension caused by transcription.

D. The nucleosomes adjust the tension by binding to positively supercoiled regions behind a moving RNA polymerase.

E. All of the above.

57. Comparing mRNA molecules from human and *Escherichia coli* cells, which of the following is typically NOT true?

A. A human mRNA has a special 5' cap, while a bacterial mRNA does not.

B. A human mRNA has a poly-A tail, while a bacterial mRNA does not.

C. A human mRNA undergoes alternative splicing, while a bacterial mRNA does not.

D. A human mRNA contains noncoding sequences, while a bacterial mRNA does not.

E. A typical human mRNA encodes one protein, while many bacterial mRNAs encode several different proteins.

58. Eukaryotic pre-mRNAs undergo a number of modifications such as capping at the 5' end. A 5' cap…

A. consists of a modified terminal adenine nucleotide.

B. has a 3'-to-5' linkage between the terminal nucleotide and the 5' end of the pre-mRNA.

C. contains a triphosphate bridge between the terminal base and the 5' end of the pre-mRNA.

D. carries a negative charge in the terminal base due to methylation.

E. is identical for all mRNAs that are transcribed by RNA polymerase II.

59. After the first and before the second chemical step of RNA splicing, the intron of the pre-mRNA…

A. is still covalently connected to the 3' exon and has an internal branch in the shape of a lariat.

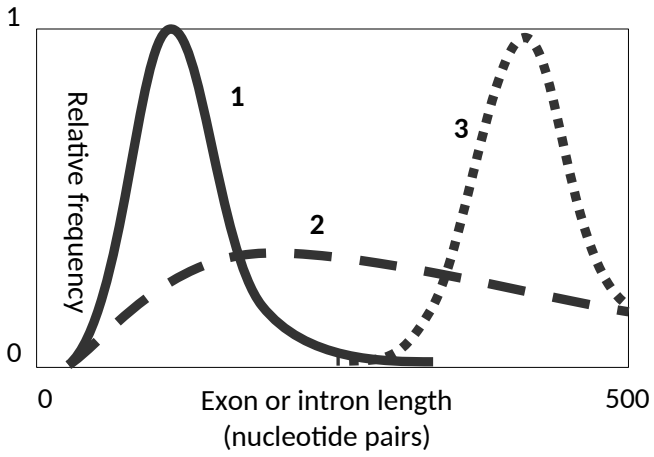
B. is still covalently connected to the 3' exon and is linear.

C. is still covalently connected to the 5' exon and has an internal branch in the shape of a lariat.

D. is still covalently connected to the 5' exon and is linear.

E. is still covalently connected to both of its flanking exons and is linear.

60. In the following qualitative histogram, which two curves better correspond to human exon and intron length distributions, respectively?



A. Curves 1 and 2

B. Curves 2 and 1

C. Curves 2 and 3

D. Curves 3 and 2

E. Curves 3 and 1

61. To ensure the fidelity of splicing, the spliceosome…

A. hydrolyzes ATP to undergo complex rearrangements.

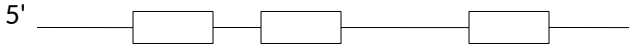
B. examines the splicing signals on the pre-mRNA several times.

C. assembles on the pre-mRNA co-transcriptionally.

D. takes advantage of “exon definition.”

E. All of the above.

62. A primary mRNA transcript with three exons is depicted below. Which of the following mature mRNA products of this transcript is a result of exon skipping?

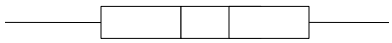


A. 

B. 

C. 

D. 

E. 

63. The enzyme poly-A polymerase is responsible for adding 3' poly-A tails to eukaryotic mRNAs. This enzyme…

A. cuts the mRNA after recognition of the cleavage/polyadenylation signal by CstF and CPSF proteins.

B. polymerizes the tail using an RNA template that is part of the enzyme.

C. is extremely processive.

D. normally adds about 1000 A nucleotides to the mRNA.

E. uses ATP as a substrate.

64. Several mechanisms contribute to the diversity of the mRNAs and proteins encoded by a single gene in our genome. Which of the following is normally NOT one of them?

A. Alternative choice of polyadenylation sites

B. Alternative choice of translation initiation sites

C. Alternative choice of transcription initiation sites

D. Alternative choice of the reading frames

E. Alternative choice of splice sites

65. Which of the following better describes a typical, actively translated mRNA in its journey from the nucleus to the cytosol?

A. Initially in a circular conformation, the mRNA linearizes, enters the cytosol (5' end first), and remains linear.

B. Initially in a circular conformation, the mRNA linearizes, enters the cytosol (3' end first), and remains linear.

C. Initially linear, the mRNA enters the cytosol (5' end first), and adopts a circular conformation.

D. Initially linear, the mRNA enters the cytosol (3' end first), and adopts a circular conformation.

E. Initially linear, the mRNA enters the cytosol (3' end first), and remains linear.

66. As an mRNA molecule is processed in the nucleus, it loses some proteins and binds to new ones, some of which are used in mRNA surveillance pathways. The presence of which of the following molecules on an mRNA is a signal that the mRNA is still NOT ready for nuclear export?

A. Cap-binding complex

B. Exon junction complex

C. snRNPs used in splicing

D. poly-A-binding proteins

E. SR proteins

67. The nucleolus is a dynamic subcompartment within the nucleus and its size varies depending on the circumstances. In which of the following cells would you NOT expect to see the nucleoli?

A. A yeast cell undergoing DNA replication

B. A human neuron in a quiescent (G_0) state

C. A human macrophage active in phagocytosis

D. A fruit fly embryonic nucleus in the G_2 phase of the cell cycle

E. A mouse embryonic cell in the metaphase stage of mitosis

68. Cajal bodies in the eukaryotic cell nucleus…

A. are stockpiles of fully mature snRNPs and other RNA processing components.

B. can only be observed by electron microscopy.

C. are absolutely required in all cell types.

D. speed up the maturation and assembly of snRNPs and snoRNPs.

E. are the main sites of pre-mRNA splicing.

69. Which of the following processes takes place in the nucleoli within the eukaryotic nucleus?

A. Ribosome assembly

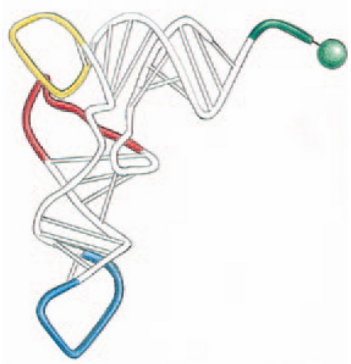
B. rRNA gene transcription

C. Telomerase assembly

D. tRNA processing

E. All of the above

70. Which of the following is true about the molecule shown in the following drawing?



A. Its gene is transcribed by RNA polymerase I.

B. There are about 50 genes in our genome encoding this type of molecule.

C. This molecule normally undergoes various covalent modifications.

D. It is normally composed of about 20 monomers.

E. Its gene transcript normally undergoes alternative splicing.

71. How is tRNA splicing different from mRNA splicing in eukaryotic cells?

A. tRNA splicing does not proceed via transesterification reactions.

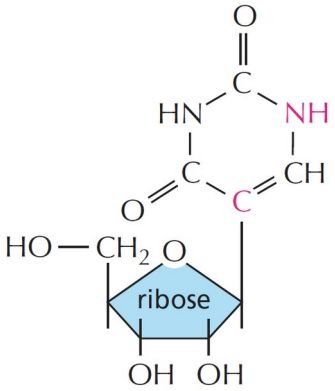
B. tRNA splicing is carried out by proteins only.

C. tRNA splicing does not create a lariat intermediate.

D. tRNA splicing involves RNA endonuclease and RNA ligase activities.

E. All of the above.

72. The modified nucleotide shown below is normally found in mature…



A. tRNAs.

B. ribosomes.

C. spliceosomes.

D. snoRNAs.

E. All of the above.

73. Each aminoacyl-tRNA synthetase activates a certain amino acid by attaching it to its corresponding tRNA(s) through a high-energy linkage…

A. between the amino group of the amino acid and the 3' hydroxyl group of the tRNA.

B. between the amino group of the amino acid and the 5' hydroxyl group of the tRNA.

C. between the carboxyl group of the amino acid and the 3' or 2' hydroxyl group of the tRNA.

D. between the carboxyl group of the amino acid and the 5' hydroxyl group of the tRNA.

E. between the amino group of the amino acid and the 3' or 2' hydroxyl group of the tRNA.

74. Activation of an amino acid by an aminoacyl-tRNA synthetase involves the covalent linkage of…

A. AMP to the amino acid.

B. ADP to the amino acid.

C. AMP to the tRNA.

D. ADP to the tRNA.

E. ADP to the enzyme.

75. On the ribosome, the mRNA is read from …, and the polypeptide chain is synthesized from…

A. 5' to 3'; C- to N-terminus.

B. 5' to 3'; N- to C-terminus.

C. 3' to 5'; C- to N-terminus.

D. 3' to 5'; N- to C-terminus.

76. An elongating ribosome is bound to appropriate tRNAs in both the A and the P sites and is ready for peptidyl transfer. What happens next?

A. The carboxyl end of the polypeptide chain is released from the P-site tRNA and joined to the free amino group of the amino acid linked to the A-site tRNA.

B. The amino end of the polypeptide chain is released from the P-site tRNA and joined to the free carboxyl group of the amino acid linked to the A-site tRNA.

C. The carboxyl end of the amino acid is released from the A-site tRNA and joined to the free amino group of the polypeptide chain linked to the P-site tRNA.

D. The amino end of the amino acid is released from the A-site tRNA and joined to the free carboxyl group of the polypeptide chain linked to the P-site tRNA.

77. Which of the following nucleotides is hydrolyzed in both transcription and in translation elongation?

A. ATP

B. GTP

C. TTP

D. UTP

E. CTP

78. How fast does a bacterial ribosome move on an mRNA?

A. At about 2 nucleotides per second, significantly lower than the speed of the RNA polymerase.

B. At about 5 nucleotides per second, comparable to the speed of the RNA polymerase.

C. At about 10 nucleotides per second, significantly lower than the speed of the RNA polymerase.

D. At about 20 nucleotides per second, comparable to the speed of the RNA polymerase.

E. At about 60 nucleotides per second, comparable to the speed of the RNA polymerase.

79. Which of the following features is common between the bacterial and eukaryotic ribosomes in translation initiation?

A. They both use an initiator tRNA that carries formylmethionine.

B. They both bind to the 5' end of the mRNA and move forward to find the start codon.

C. They both recognize the start codon by interacting with the Shine–Dalgarno sequence.

D. They both interact with various translation initiation factors.

E. All of the above.