14.20 Practice exam Questions for fun

1. **If you know that a region of double-stranded DNA has a content of 60% G/C base pairs and 40% A/T base pairs, then what is the ratio of purines to pyrimidines in the DNA?**

    a. 60:40
    b. 40:60
    c. 50:50
    d. 20:80
    e. cannot be determined from the above information

2. **Interphase is**

    a. the interval between lag phase and log phase
    b. the combination of G_1, S, and G_2
    c. the time that RNA polymerase terminates transcription
    d. the stage between prophase and metaphase
    e. the joining of the large and small ribosomal subunits

3. **In a diploid cell in the metaphase of mitosis there are 100 chromatids. The haploid number of chromosomes for this organism would be:**

    a. 200
    b. 100
    c. 50
    d. 25
    e. cannot accurately decide based on data given

4. **Which of the following mutations would you expect to have the most disastrous effect on the roduct of a protein coding gene?**

    a. A deletion of one base pair near the middle of the coding sequence
    b. A change of one A-T base pair near the end of the gene to a G-C base pair
    c. A deletion of three base pairs near the beginning of the gene
    d. A change of one G-C base pair near the beginning of the gene to an A-T base pair
    e. They would all be expected to have a similar effect.

5. Which of the following double-stranded DNA molecules would require the most energy to be separated into single strands (assume all the DNAs have the same overall number of base pairs):

a. one which contained 50% G-C base pairs
b. one which contained 25% A-T base pairs
c. one which contained all A on one strand and all T on the other strand
d. one which contained all G on one strand and all C on the other strand
e. all of the above would require the same amount of energy to be separated into single strands

6. Which is not an example of protein modification in eukaryotes?

a. addition of a phosphate
b. addition of a poly(A) tail
c. addition of an iron atom
d. removal of a signal peptide
e. addition of an oligosaccharide

7. A mutation in the tumor suppressor gene p53 may promote cancer because such a mutation….

a. Prevents DNA-repair.
b. Increases the mutation rate.
c. Promotes cell division.
d. Does all of the above.

8. The following events occur in which sequence during the cell cycle:

(1) DNA replication
(2) Chromosome condensation
(3) Accumulation of the SPF
(4) DNA-repair
(5) Segregation of sister chromatids
(6) Nuclear membrane breakdown

a. 1-4-2-6-5-3-4
b. 1-4-2-6-3-5-4
c. 1-2-4-6-5-3-4
d. 1-4-2-6-5-4-3

9. Which of the following cellular process would be inhibited by colchicine?
1) Cytokenesis.
2) Distribution of pigment in melanophores of fish.
3) Organization of the Golgi apparatus.
4) Acrosomal reaction in echinoderm sperm.
5) Retrograde transport of vesicles in axons.

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

10. In a given area of the cytoplasm in a non-dividing cell you would expect that

a) all of the microtubules will be growing at the same time.
b) the growing ends of microtubules will have a GDP cap.
c) some of the microtubules will be growing and some will be shortening.
d) all of the microtubules will be growing at one end and shortening at the other end.
e) G-actin monomers will be added to some of the microtubules.

11. In the mitotic cell cycle,

a) DNA synthesis occurs during M phase.
b) sister chromatids are attached to each other via centrosomes.
c) RNA is made during G1 and G2.
d) interphase consists of G1 and S.
e) in anaphase A, centrosomes move away from one another.

12. Which of the following statements concerning MPF (mitosis promoting factors) is correct?

a) MPF consists of two components cyclin and c-fos.
b) Levels of cyclin oscillate during the cell cycle.
c) MPF stimulates the cells to enter S-phase of the cell cycle.
d) Cyclin levels are highest during interphase of the cell cycle.
e) Cyclin binds to cdc2 to decrease the activity of the kinase.

13. In the control of the cell cycle,

a) MPF brings cells out of the G0 phase of the cell cycle.
b) c-jun phosphorylates lamin to cause breakdown of the nuclear membrane.
c) growth factors bind to nuclear receptors to initiate transcription of c-fos.
d) cyclin is an example of a delayed-response gene.
e) growth factors must be present after the restriction point for cell cycle progression.

14. With respect to the GO state, which of the following statements are CORRECT?

1. Proliferating cells in vertebrates leave the cell cycle in G1 to enter the GO state.
2. Exit from the GO state can be triggered by growth factors.
3. The anaphase promoting complex is degraded during GO.
4. Cells are transcriptionally active during GO.
5. The GO state is restricted to oocytes.

a) 1 and 4
b) 2 and 4
c) 3 and 5
d) 1 and 3
e) 4 and 5

15. Which of the following statements are CORRECT?

1. Mitotic events can be observed with a light microscope.
2. Sister chromatids are generated during prophase.
3. Centrosomes are duplicated during G2.
4. Cytokinesis requires myosin II motors.
5. Chromosome condensation begins during telophase.

a) 1 and 4
b) 2 and 4
c) 3 and 5
d) 1 and 2
e) 3 and 5

16. With respect to anaphase A, which of the following statements are CORRECT?

1. Kinesins promote disassembly, not movement, of chromosomes along microtubules.
2. Chromosome movement towards the centromeres requires ATP as an energy source.
3. The kinetochore-associated motor, MCAK, promotes anchoring to microtubules.
4. The kinetochore-associated motor, CENP-E, promotes anchoring to microtubules.
5. Depolymerization of kinetochore microtubules occurs from the (-) end.

a) 1 and 2
b) 2 and 4
c) 2 and 5

d) 1 and 4
e) 4 and 5

17. Which of the following statements are CORRECT?

1. Only microtubule motors can transport secretory vesicles.
2. Like kinesin, dynein motors can mediate cargo transport by themselves.
3. Multiple motors proteins can move the same cargo in a cell.
4. Organelles and mitochondria move down axons faster than tubulin subunits.
5. Dynein motors promote flagella movement.

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

18. Which of the following statements concerning structure and synthesis of DNA are correct?

1. Purines are linked via their nitrogen in position 9 to the 1' carbon of deoxyribose.
2. The pentose sugar in DNA has an hydroxyl group on the 2' carbon.
3. Ribonucleoside triphosphates are used to elongate DNA.
4. In the DNA double helix, 2 hydrogen bonds form between the complementary bases adenine and thymine.
5. A piece of double stranded DNA that is rich in G and C residues has a higher Tm in comparison to one that is rich in AT residues.

a. 2,3,4,5
b. 2,4,5
c. 1,2,3,4
d. 1,4,5
e. 1,4

19. Which of the following statements concerning RNA are correct?

1. RNA is synthesized in the 3' to 5' direction.
2. RNA contains ribose.
3. The following nitrogenous bases are found in RNA: uracil, adenine, cytosine, guanine.
4. In eukaryotes the 5' end of the primary RNA transcript is modified.
5. If the sequence of the DNA template strand is 3'AAA TCG CCC 5', then the sequence of the RNA transcript is 5' UUU AGC GGG 3'.

a. 1,2,3,4,5
b. 2,3,4,5
c. 1,2,4,5
d. 1,2,3,4
e. 1,3,5

20. Telomeres are found at the end of chromosomes and they are synthesized by telomerase. Which one of the following statements is correct?

a. Telomerase is an unusual enzyme made up of RNA and protein.
b. Telomers code for ribosomal RNA.
c. The function of telomerase is to directly elongate the leading strand during DNA replication.
d. Telomerase is active in all cell types.
e. Telomeres are longer in yeast in comparison to humans.

21. In eukaryotes the primary RNA transcript undergoes processing. Which of the following statements concerning RNA processing are correct?

a. The multiple adenylate residues, found at the end of mRNA, are coded for by DNA
b. The 3' end of the primary RNA transcript is modified by a 5'- 3' linkage to 7-methylguanylate.
c. Exons in the primary RNA transcript are removed and the mature mRNA contains only intron sequences.
d. There are specific nucleotides found at the exon/intron boundaries that are required for RNA splicing.
e. The primary RNA transcript is cleaved near (about 10-35 nucleotides downstream of) the polyadenylation signal.

a. 2,4,5
b. 1,2,4,5
c. 3,4,5
d. 3,5
e. 4,5

22. Which one of the following concerning cleavage and polyadenylation of eukaryotic RNA is correct?

a. The cleavage and polyadenylation specificity factor (CPSF) binds to the polyadenylation signal.
b. The polyadenylation signal is a G-C rich inverted repeat.
c. Polyadenylation binding protein (PABII) adds the first 12 adenylate residues to the RNA transcript.
d. Adenylate residues are added to the OH group of the 2¢ carbon.

23. Another type of RNA processing is RNA splicing. Which of the following statements are correct?

a. GU residues are always found at the 5' end of the intron.
b. An adenylate residue is always found at the branch point.
c. In the first transesterification reaction during RNA splicing, an ester bond forms between the 5' phosphorous of the intron and the 2' oxygen of the branch site adenylate residue.
d. When splicing has been completed, the intron that is released has a stem loop structure.
e. AG residues are always found at the 3' end of the intron.

a. 1,2,3,4,5
b. 2,3,4
c. 1,3,5
d. 1,2,3,5
e. 2,4,5

24. Which of the following statements concerning translation are correct?

1. The most common start codon for translation is TAC.
2. The stop codons, UAA, UGA, and UAG, all code for the amino acid methionine.
3. The 3 nucleotides on transfer RNA that are complementary to a codon on mRNA are called the anticodon.
4. Amino acids are added to the N terminal end of the growing polypeptide chain.
5. Ribosomes move along the mRNA transcript in the 5' to 3' direction.

a. 1,2
b. 3,5
c. 1,3,5
d. 2,3,4
e. 2,3,5

25. The following represent possible codon and anticodon pairs. Which one of the following would not normally occur in the cell?

a. 3'UAU5' tRNA
5'AUG3' mRNA

b. 3'UAC5' tRNA
5'AUG3' mRNA

c. 3'GAI5' tRNA
5'CUA3' mRNA

d. 3'UAC5' tRNA

5'AUU3' mRNA

e. 3'GGI5' tRNA
5'CCU3' mRNA

26. Mitochondria and chloroplasts are thought to be bacteria that invaded ancestral eukarytotic cells. Which of the following observations support this idea?

1. The genomes of the subcellular organelles code for prokaryotic like ribosomal RNAs.
2. Promoter sequences in the genome of subcellular organelles are similar to bacteria.
3. The genomes of subcellular organelles are single-stranded.
4. Translation of subcellular organelle mRNAs is inhibited by antibiotics.
5. Subcellular organelle DNA is packaged with histones.

a) 1, 2, 3, 5
b) 1, 3, 4
c) 1, 2, 4
d) 2, 3, 5

27. Histones are found in close association with DNA. Which of the following statements is correct?

a. There are only four types of histones
b. A nucleosome is composed of 146 bp of DNA and a histone octomer
c. Histone H1 is less evolutionarily conserved than core histones.
d. Nucleosomes are evenly distribution within chromatin
e. Solenoids are only observed during mitosis.

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

28. With respect to the packaging of nuclear DNA, which of the following statements is NOT correct?

a. Some cis-acting regulatory elements are found in the spacer region between nucleosomes.
b. Core histones have different affinities for one another.
c. The amino acid sequence of histones varies dramatically between organisms.

d. The first step towards nucleosome displacement during transcription is the release of histone H2A-H2B dimers.

29. High salt concentrations are used in the DNA isolation and the RNA isolation laboratories to

a. degrade histones.
b. buffer the solutions.
c. prevent nucleic acid degradation.
d. promote nucleic acid precipitation.

30. The sequence of one strand of a DNA fragment is: 5'ATGCGTGACTAATTCG3'. Which of the following is the CORRECT double-stranded sequence?

a) 5'-ATGCGTGACTAATTCG-3'
3'-TACGCACTGATTAAGC-5'

b) 5'-ATGCGTGACTAATTCG-3'
5'-TACGCACTGATTAAGC-3'

c) 5'-ATGCGTGACTAATTCG-3'
3'-TUCGCUCTGUTTUUGC-5'

d) 5'-ATGCGTGACTAATTCG-3'
3'-ATGGCACTGATTAAGC-5'

e) 5'-ATGCGTGACTAATTCG-3'
3'-UACGCACUGAUUAAGC-5'

31. How many amino acids would be in the protein encoded by a gene with the sequence 3' TACCCGGATTCA 5'?

a) 1
b) 2
c) 4
d) 6
e) 12

32. Given the following DNA template strand:
3'-GCTTAATCAGTGCGTA-5'

Which of the following is the CORRECT sequence of the RNA transcript?

a) 3'-CGAAUUAGUCACGCAU-5'.

b) 5'-CGAAUUAGUCACGCAU-3'
c) 5'-CGAATTAGTCACGCAT-5'.
d) 3'-CGAATTAGTCACGCAT-5'.
e) 5'-pppCGAATTAGTCACGCAT-3'.

33. You have a polypeptide containing this sequence of amino acids: His-Met-Leu-Ile-Lys. Using the mRNA genetic code for amino acids listed below, choose the DNA template sequence that corresponds to this polypeptide.

mRNA codon	amino acid
UUA	Leu
AUU	Ile
AUC AUA AUG	Met
CAC CAU	His
AAA	Lys

34. A DNA template sequence for this polypeptide could be

a) 3'GUGUACAAUAUUUUU5'.
b) 3'GTGTACAATATTTTT5'.
c) 3'GTATACAATTAATTT5'.
d) 3'GUAUACAAUUAUUUU5'.
e) 3'CAUAUGUUAAUAAAA5'

35. Which one of the following anticodon and codon pairs is not normally observed *in vivo*?

a) 3' UAC 5' tRNA
5' AUG 3' mRNA

b) 3' GAI 5' tRNA
5' CUC 3' mRNA

c) 3' GAI 5' tRNA
5' CUU 3' mRNA

d) 3' AUA 5' tRNA
5' UAU 3' mRNA

e) 3' UAC 5' tRNA
5' AUU 3' mRNA

36. For translation to proceed in *E. coli*, which of the following must occur?

1. The Shine-Delgarno sequence of the mRNA binds the 3'-end complementary 16S RNA
sequence.
2. The anticodon UAC binds to the AUG codon at the P site of the ribosome.
3. A tRNA carrying an appropriate amino acid binds to the A site of the ribosome.
4. Peptide bond formation occurs between the amino acid in the P site and the second amino acid in the A site.
5. Translocation of the mRNA one codon length through the ribosome, bringing the newly formed peptidyl tRNA to the P site.

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

37. Vasopressin is a hormone released from the posterior pituitary of humans. The hormone is a small protein consisting of nine amino acids. Which one of the following is true of nucleotide sequences that code for this hormone?

a) The cytoplasmic mRNA message is nine nucleotides long.
b) The cytoplasmic mRNA message is three nucleotides long.
c) The cytoplasmic mRNA is more than 27 nucleotides long; cytoplasmic mRNA includes intron sequences.
d) The DNA coding for vasopressin is more than 27 nucleotides long; the messenger transcript is processed in the nucleus.
e) The cytoplasmic mRNA is less than 27 nucleotides long; intron sequences are spliced out.

38. Which of the following concerning vertebrate pre-mRNA are CORRECT?

1. Pre-mRNA contains a 5' splice site with GU found at the 5' end of the intron.
2. Pre-mRNA contains AG at the 3' end of the intron.
3. U is always found at the branch point.
4. Splicing of exons in pre- mRNA occurs via two transesterification reactions.
5. Small nuclear RNAs (snRNAs) assist in the splicing reaction.

a) 3, 4, 5

b) 1, 2, 3, 5
c) 1, 2, 3, 4, 5
d) 1, 2, 4, 5
e) 2, 3, 4

39. During DNA lagging strand synthesis, which of the following is NOT CORRECT?

a) RNA primers are copied from the DNA template by primase.
b) DNA polymerase III catalyzes the elongation at the growing fork.
c) Each Okazaki fragment is produced in the 5' to 3' direction from its own RNA primer.
d) Each RNA primer is elongated by addition of ribonucleotides to its 5' end.
e) DNA polymerase I has exo nuclease activity and polymerase activity.

40. Which of the following concerning DNA replication is CORRECT?

a) DNA replication in eukaryotes is bidirectional from multiple origins of replication.
b) DNA replication is conservative in eukaryotes and prokaryotes.
c) DNA leading strand synthesis proceeds using DNA polymerase III and a DNA primer.
d) DNA polymerase III joins adjacent Okazaki fragments.
e) Single-stranded binding protein has helicase activity that separates duplex DNA strands.

41. 5' AUGAAACAGGCGUAA 3' is a short mRNA sequence. The strand of the DNA that codes for this message will be?

a) 5' AUGAAACAGGCGUAA 3'.
b) 5' TACTTTGTCCGCATT 3'.
c) 5' TTACGCCTGTTTCAT 3'.
d) 5' UUACGCCUGAAACAU 3'.
e) 5' TTHISISWRONGAAT 3'.

42. Transfer RNAs are active in the process of translation. Which of the following is CORRECT?

a) Inosine can form non-standard base pairs with any of the five bases.
b) There is only one tRNA synthetase.
c) A single tRNA anticodon recognizes only one codon.
d) Aminoacyl-tRNA synthetases activate amino acids by linking them to tRNA.
e) The acceptor arm of tRNA is located in the 5' direction.

43. RNA has three roles in protein synthesis. Which of the following is CORRECT?

a) A reading frame is an uninterrupted sequence of codons in mRNA from a specific start codon to a stop codon.
b) Decoding the nucleotide sequence in 16S rRNA into the amino acid sequence of a protein requires tRNA and amino-acyl tRNA synthetases.
c) Each of the 20 aminoacyl-tRNA synthetases recognizes at least 61 codons.
d) Ribosomes contain rDNA and at least two subunits.
e) Transfer RNAs have distinct tertiary structures determined by codon-anticodon interaction.

44. Which of the following is NOT CORRECT?

a) In prokaryotic cells, translation of an mRNA into protein can begin even while the 3' end is still being transcribed from DNA.
b) In eukaryotes the 5' end cap contains 7-methylguanylate.
c) In eukaryotic mRNA there is a 5'-3' linkage to 7-methylguanylate.
d) Three phosphate groups are located at the 5' end of eukaryotic mRNA and are covalently linked to 7-methylguanylate.
e) The initial steps in the processing of all eukaryotic primary mRNA transcripts occur at the two ends, and the modifications are retained in mRNAs.

45. Automated DNA sequencing has greatly facilitated our ability to obtain rapid and reliable DNA sequences. With respect to this method, which of the following statements are true?

1. The investigator does not need to know the primer sequence.
2. All four fluorescently labeled ddNTPs are added to the same reaction tube.
3. The template sequence is the reverse complement of the sequence generated.
4. Several different DNA templates can be sequenced simultaneously in one tube.
5. The DNA strand being sequenced is always complementary to the mRNA.

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

46. With respect to manual DNA sequencing, which of the following statements are false?

1. Only double-stranded DNA templates can be sequenced.
2. Four reactions must be performed per template.
3. A maximum of 20 bases can be sequenced per reaction.
4. A ratio of dNTP to ddNTP of 10:1 is commonly used.

a) 1, 3, 4
b) 2, 4

c) 1, 3
d) 2, 3
e) 1, 4

47. Which of the following would you never expect to be associated with a dicistronic mRNA in *E.coli*?

1. A G-C rich stem loop followed by a poly-U stretch.
2. A Shine-Delgarno sequence immediately downstream of an initiation codon.
3. A 3' untranslated region.
4. A promoter sequence.

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

48. The differences between rRNAs and mRNAs are:

1. some mRNAs can contain several ORFs.
2. rRNAs contain only one ORF.
3. rRNAs have no role in translation.
4. rRNAs are much more abundant than mRNAs.

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

49. Microsatellite and minisatellite alleles are used in forensic science because

1. of the large number of microsatellites and minisatellites.
2. their G-C rich sequences makes it easier to amplify.
3. these seque nce elements are only found in human DNA.
4. the number of repeats per cluster varies between individuals.
5. they are found at telomeres.

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

50. The formation of a stem- loop structure between region 2 and 3 of the leader RNA of the trp operon is favoured when

a) the holoenzyme is transcribing region 4.
b) a ribosome is paused at the trp codons in the leader RNA.
c) a ribosome is paused at the stop codon of the leader RNA.
d) the repressor is overlapping region 1.

51. Binding sites for proteins that regulate transcription in prokaryotes

1. are often found upstream of the start of transcription.
2. often contain inverted repeats.
3. are A-T rich.
4. are identical for different transcriptional units.

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

52. With respect to transcription initiation in *E. coli*, which of the following statements are correct?

1. An initiation complex is formed by the core polymerase.
2. Since the trp operator (-27 to +3) overlaps more with the promoter than the lac operator (-3 to +21), repression of transcription initiation by the trp repressor is more efficient than with the lac repressor.
3. Sigma factors are required for core enzymes to bind with high affinity to promoters.
4. The more similar the sequence of a promoter is to the consensus sequence, the higher the frequency of transcription initiation.

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

53. You wish to construct a plasmid that will express green fluorescent protein (GFP) as a reporter gene in *E. coli*. Which of the following sequence elements would you add to your plasmid?

1. An origin of DNA replication.
2. A multiple cloning site.

3. An inducible promoter.
4. A host chromosome integration site.
5. A transcription termination site at the end of the GFP ORF.

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

54. Failure to add IPTG to the culture medium when LacZ is used as a cloning vector will result in

1. The production of defective α-peptide.
2. Very little expression of α-peptide.
3. Only white colonies.
4. Growth of non-transformed bacteria.

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

55. Prokaryotic genomes are associated with polyamines to

1. neutralize the negative charge of DNA.
2. enhance binding of transcription factors.
3. package the DNA.
4. stabilize the transcriptional machinery.

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

56. The reason some plants have much greater amounts of DNA in their genomes than human genomes is that

a) Plant genomes have many more protein and RNA coding genes.
b) Many plant genomes have greater amounts of non-transcribed spacer DNA.
c) Plant genomes are more ancient than animal genomes.
d) Genes coding for enzymes required for photosynthesis have been duplicated hundreds of time.

57. Which of the following statements are true about rRNA transcription in human cells?

1. Intron removal by splicesomes generates one copy 18S, 5.8S and 28S rRNA per pre-ribosomal RNA.
2. Ribosomal RNAs are assembled with ribosomal proteins.
3. To ensure sufficient rRNAs are made, transcription is carried out by all three types of RNA polymerases.
4. Tandem copies of the rRNA gene are found in the genome.

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

58. A point mutation has occurred in the leader DNA sequence of the trp operon such that one of the trp codons UGG (codon #9) has been changed to a stop codon. What effect would this have on the production of full-length mRNA molecules in a culture medium containing low levels of trp?

a) Higher levels of full-length trp mRNA would be produced.
b) Lower levels of full-length trp mRNA would be produced.
c) The levels of full-length trp mRNA synthesized wo uld not change.
d) Binding of the ribosome to the ORF would be decreased.
e) The rate of transcription initiation would be decreased.

59. Several post-synthetic modifications of histones occur that promote chromatin remodeling. Acetylation of core histones:

1. decreases binding of the C-terminal domains of histones to DNA.
2. decreases binding of the N-terminal domains of histones to DNA.
3. promotes direct binding of activators to TATA box promoter elements.
4. promotes binding of general transcription factors to promoters.

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

60. Which one of the following techniques is used to demonstrate the presence of DNase-sensitive sites in euchromatin?

a) Automated DNA sequencing.
b) Southern blot analysis.

c) Northern blot analysis.
d) DNA fingerprinting.

61. Features shared by most transcription activators are

1. Insertion of DNA binding domains in the major groove of DNA.
2. Modular organization.
3. Homodimer formation.
4. Domains which interact with upstream DNA elements.

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

62. Which of the following statements concerning DNA structure are CORRECT?

1. Forces that stabilize the double helix structure of DNA include hydrogen bonds, van der Waals forces and ionic interactions.
2. In complementary base pairing of cytosine and guanine, two hydrogen bonds stabilize the interaction.
3. Ribose is linked by the 5' carbon to an oxygen atom.
4. Adenine is covalently attached to the 1' carbon of deoxyribose.
5. Adenine is covalently attached from the 9' nitrogen to the 1' carbon of deoxyribose.

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

63. Which of the following statements concerning purine and pyrimidine structure are CORRECT?

1. Adenine is a purine that binds via three hydrogen bonds to thymine.
2. Uracil is covalently attached to the 1' carbon of deoxyribose in DNA.
3. Guanine/cytosine and adenine/thymine complementary pairs are stabilized by three and two hydrogen bonds, respectively.
4. The melting temperature (T_m) of DNA is related to the hydrogen bonding between complementary base pairs.
5. In nucleic acids and nucleotides, nitrogen 9 of purines and nitrogen 1 of pyrimidines are bonded to the 1' carbon of ribose or deoxyribose.

a) 1, 2
b) 3, 4, 5

c) 1, 2, 4, 5
d) 2, 3, 4, 5
e) 1, 3, 5

64. Which of the following statements is NOT CORRECT?

a) The subunits of DNA and RNA are nucleotides.
b) Nucleotides have a phosphate group attached through a phosphodiester bond.
c) A DNA precursor is deoxyadenosine-5'-triphosphate (dATP), which loses two phosphate groups when synthesis of DNA occurs.
d) The DNA molecule has a 5' end bearing a phosphate group and a 3' hydroxyl group.
e) Nucleotides contain a base linked to the 5' position of deoxyribose or ribose.
The process of synthesizing mRNA along a DNA template is called

a) transcription.
b) translation.
c) transformation.
d) replication.
e) translocation.

65. Restriction endonuleases

1. are associated with chromatin.
2. can digest single-stranded DNA.
3. protect bacteria from foreign DNA.
4. prefer A-T rich sequences.
5. usually don't cleave methylated bases.

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

66. An agarose gel was used to fractionate your RNA because

a) DNA contamination will remain in the well.
b) only agarose gels can be stained with bromophenol blue.
c) both high and low molecular weight RNAs can be resolved.
d) agarose inhibits RNases.

67. A loading dye was added to your nucleic acid samples before electrophoresis to

1. make the samples visible while loading on the gel.
2. provide the right ionic environment for electrophoresis.
3. make the samples denser than the running buffer.

4. to visualize the fractionated nucleic acids under UV light.

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

68. Ethanol is used to precipitate nucleic acids because

1. nucleic acids are dehydrated by ethanol.
2. double-stranded DNA is denatured by ethanol.
3. ethanol is soluble in chloroform.
4. ethanol is easy to remove after precipitation.

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

69. Messenger RNAs were not visible as discrete bands in your RNA gel because

a) the concentration of rRNAs was too high.
b) the molecular weight of mRNAs varies tremendously.
c) mRNAs are much less stable than rRNAs.
d) mRNAs were not extracted.

70. When the polymerase chain reaction (PCR) is used, it is convenient to make a "master mix" of common reagents that will be dispensed into each sample of DNA to be amplified. The key ingredients of this master mix are:

a) buffer, deoxyribonucleotides (4 types), DNA primers, heat-stable DNA polymerase.
b) buffer, deoxyribonucleotides (4 types), RNA primers, heat-stable RNA polymerase.
c) restriction buffer, restriction enzyme, water, double-stranded DNA.
d) buffer, dideoxyribonucleotides (4 types), deoxyribonucleotides (4 types), heat-stable DNApolymerase, fluorescent primers.
e) only water.

71. Which of the following statements describes a DIFFERENCE between the structure of DNA and RNA?

a) In DNA, the nitrogenous base is attached to carbon 1'.
b) In DNA, the nitrogenous base can be uracil.
c) The 3' end of RNA has an hydroxyl group on carbon 3'.

d) In DNA, there is no hydroxyl group attached to carbon 2'.
During DNA replication,

72. The melting temperature (Tm)

a) is the temperature at which all of the double strands of DNA have separated.
b) increases when the number of C and G nucleotides increases.
c) is the temperature at which half of the double strands of DNA have separated.
d) increases when the number of A and T nucleotides increases.
e) b and c

73. Which of the following is correct?

a) Prokaryotic cells lack ribosomes.
b) Chromosomes in prokaryotic cells are linear.
c) The DNA in eukaryotic cells is restricted to the nucleus.
d) Eukaryotic cells contain endoplasmic reticulum.
e) Mitochondria are found in prokaryotic cells.

74. *E. Coli* were grown in medium containing ^{15}N-ammonium for a long time and then switched to medium containing ^{14}N-ammonium. A single bacterium from the old medium divides twice in this new medium to produce 4 cells. You would expect that

a) The individual strands of DNA in the cells would contain both ^{15}N and ^{14}N.
b) DNA in all four of the cells would contain ^{14}N.
c) DNA in all four of the cells would contain ^{15}N.
d) There would be two cells in which the DNA would contain only ^{15}N.
e) b and d

75. DNA replication in eukaryotic cells is usually

a) bidirectional from many origins of replication.
b) unidirectional from one origin of replication.
c) unidirectional from two origins of replication.
d) bidirectional from one origin of replication.

76. DNA replication in prokaryotes requires

a) primase to make small primers containing deoxyribonucleotides.
b) DNA polymerase III to join Okazaki fragments.
c) DNA polymerase α to synthesize DNA.
d) helicase to keep single strands of DNA separated.
e) DNA polymerase I to cut out primers and fill in gaps in the lagging strand.

77. Telomerase

a) is made up of protein and DNA.
b) adds deoxyribonucleotides to the 3' end of the parental strand.
c) uses 3' end of parental strand as a template.
d) b and c
e) a, b, c

78. Which of the following is CORRECT concerning transcription and DNA replication?

a) Only transcription requires a primer.
b) Transcription starts at the origin of replication.
c) A helicase is used to unwind DNA in transcription.
d) The entire genome is copied in transcription.
e) In DNA replication, both the coding and template strands are copied.

79. In eukaryotic transcription,

a) RNA polymerase I synthesizes transfer RNA.
b) RNA polymerase II synthesizes precursor ribosomal RNA.
c) RNA polymerase II synthesizes messenger RNA.
d) RNA polymerase II binds to the Shine Delgarno sequence.
e) RNA polymerase II synthesizes 5S ribosomal RNA.

80. Which reading frame on the following mRNA would code for the longest peptide?
5'AUGCCUGACCCUAGAUGCCAUAACGGGCUUAAAUAGAUG3'

a) first
b) second
c) third

81. If a triplet in the coding strand of DNA was 5'GAC3', the anticodon that would recognize RNA transcribed from this DNA would be

a) 3'CTG5'
b) 3'GUC5'
c) 3'CUG5'
d) 3'GUU3'
e) 3'UUU5'

82. The following codons code for arginine—CGU, CGA, CGC, and AGA. What is the minimum number of tRNAs required to recognize all these codons?

a) 1

b) 2
c) 3
d) 4
e) 5

83. A specific aminoacyl-tRNA always carries the same amino acid that is attached by a specific aminoacyl-tRNA synthetase. Regions on tRNA that are required for the specificity of the enzyme is/are the

a) anticodon and acceptor region.
b) D loop and acceptor region.
c) anticodon alone.
d) the TΨCG loop and anticodon.
e) None of the above.

84. Ribosomes may contain which of the following?

a) tRNA
b) rRNA
c) protein
d) a and c
e) a, b, c

85. Which of the following is required for the initiation of translation in prokaryotes?

a) The addition of a formyl group to the methionine attached to $tRNA_{imet}$.
b) The mRNA base pairing with the 3' end of 23S rRNA.
c) The Kozak sequence positioning the mRNA on the ribosome.
d) f-met- $tRNA_{imet}$ binding to the A site on the ribosome.
e) GTP bound to initiation factor 1 (IF1).

86. Modern sequencing is based on the original Sanger (Dideoxy) chain termination method. The DIFFERENCE between the modern and original methods is

a) in the modern method, dideoxyribonucleoside triphosphates (ddNTP) are used.
b) the modern method relies on the use of different fluorescently labelled dNTPs.
c) in the modern method, the ddNTPs are labelled instead of the primer.
d) the modern method requires the use of radioactivity.
e) b and c

87. Evidence that mitochondria originated from an endosymbiotic relationship between aerobic bacteria and ancestral eukaryotic cells includes all of the following EXCEPT

a) Regulatory DNA sequences in mitochondria are similar to those found in prokaryotes.
b) DNA in mitochondria is not packaged by histones.
c) Mitochondrial DNA is circular like prokaryotic DNA.
d) Protein synthesis in mitochondria is inhibited by antibiotics as in bacterial protein synthesis.
e) Ribosomal RNAs in mitochondria code for prokaryotic- like ribosomal proteins.

88. Which of the following is correct concerning transcription and translation in *E. Coli*?

a) transcription is counterclockwise.
b) transcription may be clockwise or counterclockwise.
c) transcription and translation do not occur at the same time.
d) transcriptional units on the different strands of DNA may overlap.
e) b and d

89. Which of the following is NOT CORRECT concerning tandemly repeated genes?

a) they do not code for proteins.
b) there are multiple copies of tandemly repeated genes.
c) there is a great deal of variability in the sequence of individual pre-rRNA genes in a single
organism.
d) a and b
e) a and c

90. Which of the following is a feature of chromatin?

a) Chromatin is found in its most condensed form in interphase.
b) Histones are the only proteins found in chromatin.
c) Histone 2A is found in the linker region of chromatin.
d) DNA that is actively being transcribed exists in cells as euchromatin.
e) Moderate digestion of chromatin with DNases yields amino acids and deoxyribonucleic acid.

91. With respect to the packaging of nuclear DNA, which of the following statements is NOT CORRECT?

a) Some cis-acting regulatory elements are found in the linker region between nucleosomes.
b) Core histones have different affinities for one another.
c) The amino acid sequence of histones varies dramatically between organisms.
d) The first step towards nucleosome displacement during transcription is the release of histone H2A-H2B dimers.
e) Histone 1 is larger than the core histones.

92. The following shows the ends of a piece of DNA that you would like to amplify using the polymerase chain reactio n. Which of the following are the correct set of primers that you should choose?

5' AAA GCC TTC AGA CCC---------- -AAA GGG CCA GCG TAT 3'
3' TTT CGG AAG TCT GGG----------TTT CCC GGT CGC ATA 5'

a. forward=5'TTT CGG AAG TCT GGG 3', reverse= 5'AAA GGG CCA GCG TAT3'
b. forward= 5'AAA GCC TTC AGA CCC 3', reverse= 5'ATA CGC TGG CCC TTT3'
c. forward=5'CCC AGA CTT CCG AAA 3', reverse= 5'TTT CCC GGT CGC ATA 5'
d. forward=5'AAA GGG CCA GCG TAT 3', reverse= 5'TTT CGG AAG TCT GGG 3'

93. You wish to amplify some DNA and notice that there is a high content of G and C at the ends of the sequence. You should increase the temperature in which step of the polymerase chain reaction?

a) annealing
b) denaturation
c) synthesis
d) all of the above

94. The purpose of a Northern blot is to determine if a group of cells

a) have RNA.
b) have DNA.
c) express a specific protein.
d) have the gene for a specific protein.
e) express RNA that codes for a specific protein.

95. Which of the following is NOT a characteristic of DNA?

a) It is less susceptible to alkaline hydrolysis than RNA.
b) It has a hydroxyl group attached to the 3' carbon at the 3' end.
c) It is stabilized by hydrogen bonding, Van der Waals forces and ionic interactions.
d) It can exist in four different helical conformations.
e) It is synthesized in the 5' to 3' direction by DNA polymerase.

96. Which of the following is NOT a function of sodium dodecyl sulfate (SDS) in the isolation of DNA from animal cells?

a) Lysis of the nuclear membrane.
b) Lysis of the plasma membrane.
c) Denaturation of cellular proteins.
d) Disruption of chromatin structure.
e) Precipitation of proteins from solution.

97. Which of the following types of DNA takes the form of a left handed helix?

a) Z-DNA
b) B-DNA
c) C-DNA
d) A-DNA
e) none of the above

98. The three kinds of rRNA found in *E. coli* are

a) 25S, 16S, 3S
b) 23S, 16S, 5S
c) rRNA, mRNA, tRNA
d) 28S, 18S, 5.8S, 5S
e) operon, primary transcript, end products

99. When the first draft of the human genome was published in February, 2001. Scientists reported that the human genome contained

a) more genes than previously predicted.
b) fewer genes than previously predicted.
c) the same number of genes as previously predicted.

100. If ten percent of the nucleotides in a piece of DNA contained adenine, the percentage of nucleotides containing thymine would be?

a) ten
b) forty
c) twenty
d) eighty
e) none of the above

101. To prepare a 0.5% agarose solution in 50 ml, how much agarose powder would you add to 50 ml?

a) 1 g
b) 0.5 g
c) 0.25 g
d) 0.125 g

e) 0.1 g

102. Which of the following is not a general structural feature of a nucleotide?

a) A phosphate is attached to the 2' hydroxyl of ribose.
b) A purine or pyrimidine ring nitrogen atom is attached to the 1' carbon atom of ribose.
c) A hydroxyl group is attached to the 3' carbon atom of ribose.
d) A hydrogen atom or hydroxyl group is attached to the 2' carbon atom of ribose.
e) The phosphate is negatively charged at neutral pH.

103. Which of the following is not correct concerning the structure of RNA?

a) The monomer units used for polymerization are ribonucleoside triphosphates.
b) The monomer units are linked by phosphodiester bonds.
c) The bridge between adjacent nucleotides involves two phosphate atoms.
d) The bridge between adjacent nucleotides involves the 5' carbon and 3' carbon of adjacent subunits.
e) The 2' carbon atom of each subunit contains a hydroxyl group.

104. In which of the following DNA duplexes would complementary bases dissociate at the lowest temperature?

a) 5'-GCGCGCGC-3'
3'-CGCGCGCG-5'

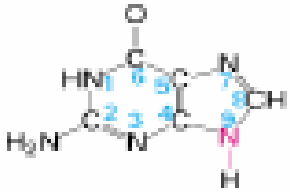
b) 5'-ATATATAT-3'
3'-TATATATA-5'

c) 5'-GATCGATC-3'
3'-CTAGCTAG-5'

d) 5'-GGGGAAAA-3'
3'-CCCCTTTT-5'

e) 5'-GGGGGGGG-3'
3'-CCCCCCCC-5'

105. The nitrogenous base shown is:



a) thymine
b) uracil
c) adenine
d) cytosine
e) guanine

106. Which of the following statements concerning DNA replication initiation in *E. coli* is not correct?

a) The *E. coli* chromosome has a single replication origin termed oriC.
b) OriC is about 240 base pairs long and contains four 9 base pair repeats that are bound by a cluster of DnaA proteins.
c) The DNA wraps around the DnaA cluster, which helps "melt" local AT-rich repeats.
d) The "melted" region serves as a binding location for Helicase.
e) Unlike Okazaki fragments, a RNA primer is not required to initiate leading strand synthesis.

107. When *E. coli* is grown for 500 generations in N_{15}, a heavy isotope of nitrogen, and is subsequently transferred for one generation to N_{14}, the normal isotope of nitrogen, all of the DNA isolated from the *E. coli* had an intermediate density between that formed with N_{15} and that formed with N_{14} when analyzed by cesium chloride density ultracentrifugation. Which of the following models of DNA replication did the above result demonstrate to be incorrect?

a) Semiconservative replication.
b) Dispersive replication.
c) Conservative replication.
d) Dispersive and conservative replication.
e) Dispersive and semiconservative replication.

108. DNA polymerase III occurs in *E.coli*. Theoretically, how may DNA polymerase III molecules should be required for the entire *E. coli* chromosome to be replicated?

a) One.
b) Two.
c) Four.
d) About 100.
e) About 1,000.

109. Choose the statement (a-e) that correctly completes the following: Eukaryotic organisms have linear chromosomes and use a special mechanism to extend the lagging strand template ends because

a) DNA polymerases cannot extend the lagging strand to completion at the 3' end.
b) DNA polymerases can only polymerize deoxynucleotides at the 3' end of existing
strands.
c) there is more than one eukaryotic DNA polymerase.
d) eukaryotic DNA polymerases can not reach the end of the chromosome.
e) replication is bi-directional.

110. Which of the five possible answers (a-e) below correctly completes the following phrase? The RNA component of telomerase

a) is an RNA primer used to extend the lagging strand template.
b) is used as a primer to initiate synthesis of the last Okazaki fragment of the lagging strand.
c) is a template used to extend the lagging strand template.
d) is used as a primer to elongate the leading strand template.
e) serves as a primer to initiate synthesis of the leading strand.

111. With which of the following anticodons below would the codon 5'-ACG-3' pair?

a) 5'-UGC-3'
b) 5'-TGC-3'
c) 5'-CGT-3'
d) 5'-CGU-3'
e) 5'-GCA-3'

112. Which of the following concerning transcription by RNA polymerase II is not correct?

a. The TATA box binding protein (TBP) dissociates from the RNA polymerase II after phosphorylation of the carboxy-terminal domain (CTD) of the polymerase.
b. RNA polymerase II recognizes DNA by binding to the TATA box binding
c. protein-TF IIB complex at the TATA box.
d. c) The RNA polymerase II has an unphosphorylated carboxy-terminal domain when it forms the preintiation complex.
e. d) Transcription factor TFIIH binds with the preintiation complex to form the
f. transcription-initiation complex.
g. e) RNA polymerase II elongates a molecule of mRNA after phosphorylation of the carboxy-terminal domain.

113. Which of the following occurs first during DNA replication initiation in *E. coli*?

a) Primase synthesizes a RNA primer.
b) Single strand binding protein (SSB) coats single-stranded DNA.
c) A specific region of the *E. coli* chromosome wraps around a cluster of DnaA polypeptides.
d) DnaC loads the enzyme helicase onto the DNA template.
e) Helicase melts the DNA duplex.

114. Which enzyme catalyzes phosphodiester bond formation between two adjacent Okazaki fragments after the primers have been removed and the gap has been filled with appropriate nucleotides?

a) DNA polymerase III.
b) DNA polymerase α (alpha).
c) DNA ligase.
d) DNA polymerase I.
e) DNA polymerase δ (delta).

115. The codon 5'-AUC-3' pairs with which of the following anticodons?

a) 5'-UGC-3'
b) 5'-IAU-3', 5'-GAU-3'
c) 5'-GIT-3'
d) 5'-CGU-3', 5'-GII-3'
e) 5'-NOT-3', 5'-ITT-3'

116. Consider the following piece of eukaryotic RNA: 3'-AUCCUGAAUUAGA-5' If you synthesize the complementary DNA single strand to the above piece of RNA, and hybridize the synthetic DNA strand to each of the following five DNA fragments, which hydrid duplex would have the highest melting temperature (Tm)?

a) 5'-AAGTCCT-3'
b) 5'-TAAGTCCT-3'
c) 5'-TAAGTCC-3'
d) 5'-ATTAAGTC-3'
e) 5'-TCCTGAATT-3'

117. Which of the following concerning intron splicing of pre-mRNA is not correct?

a) All introns have 5'-GU, 3'-AG splice sites, and an (A) residue at the branch point.
b) U1 small nuclear RNA (U1 snRNA) binds the 5'-GU bases of an intron by complementary base pairing.
c) U2 snRNA directly binds by complementary base pairing the 3'-AG splice site bases.

d) U2 snRNA binds with several intron bases at the branch point near the 3' end of an intron but does not base pair with the 3'-AG splice site bases.
e) U1, U2, U4,U6 and U5 form a complex called a spliceosome.

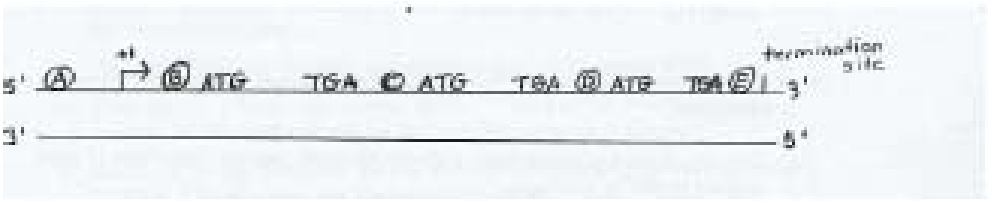
118. Which of the following is not a general characteristic of non-standard base pairing between codons and anticodons?

a) When the bases, C, A, or G are in the first, or wobble, position (5' 3') of the anticodon, then the tRNA may recognize, the bases, G, U, or C, respectively, in the third position (5' 3') of a mRNA codon.
b) When the base Inosine (I) is in the first, or wobble, position (5' 3') of the anticodon, then the tRNA may recognize, the bases, C, A, or U in the third position (5' 3') of a mRNA codon.
c) When the base U is in the third, or wobble, position (5' 3') of the mRNA, then the codon may be recognized, by a tRNA having the bases, A, G, or I in the first position (5' 3') of the anticodon.
d) When the base C is in the third, or wobble, position (5' 3') of the mRNA, then the codon may be recognized, by a tRNA having the bases, G or I in the first position (5' 3') of the anticodon.
e) When the base I is in the third, or wobble, position (5' 3') of the mRNA, then the codon may be recognized, by a tRNA having the bases, A, G, or I in the first position (5' 3') of the anticodon.

119. Which of the following concerning *E. coli* RNA polymerase is not correct?

a) It is an enzyme consisting of two types of Beta subunits (beta and beta1), an alpha subunit and a sigma subunit.
b) The core enzyme is composed of two alpha subunits joined with beta and beta 1 subunits.
c) In the absence of sigma 70 factor the core RNA polymerase binds the -10, -35 promoter regions upstream of the transcription site as well as the transcription initiation (+1) site and transcribes the DNA to completion.
d) The consensus sequences of the (-35) and (-10) promoter regions are believed to include the sequences, TTGACAT and TATAAT, respectively.
e) Sigma 70 is required to lead the RNA polymerase to the correct promoter site.

120. The following is a diagram of double-stranded prokaryotic DNA and should be used to answer the next **three** questions. All start and stop codons are indicated.



Shine Dalgarno sequences would be located at which of the following letters?

a) A only
b) B only
c) E only
d) A, B, C, and D
e) B, C, and D

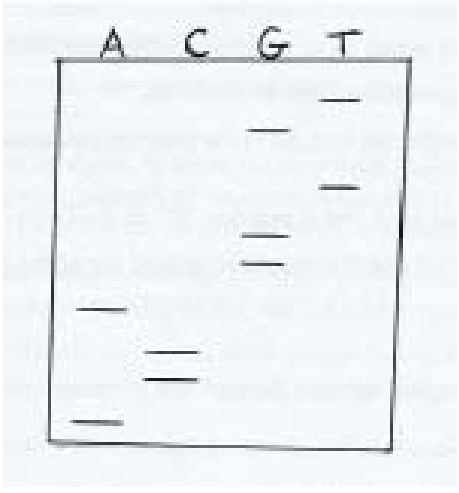
121. If the DNA in the diagram was transcribed and translated, which of the following would be the correct observation?

a) The mRNA transcribed would be an exact copy of the top DNA strand.
b) One mRNA and three proteins would be produced.
c) In this complex transcriptional unit, all of the proteins produced are coded by one gene.
d) RNA polymerase would bind first at position "B" on the DNA.
e) Regions indicated by "C" and "D" would be spliced out of the final mRNA transcript.

122. What is the name for the region between the start site of transcription and the first ATG?

a) Promoter.
b) 3' untranslated region.
c) Start site for translation.
d) Polyadenylation signal.
e) 5' untranslated region.

123. The following is a diagram of a sequencing gel. What is the sequence of the DNA that was used as the template in the sequencing reaction?



a) 5' ACC AGG TGT 3'

b) 5’ ACA CCT GGT 3’
c) 5’ TGG TCC ACA3’
d) 5’ TGT GGA CCA 3’
e) 3’ ACC AGG TGT 5’

124. Automated sequencing is based on the original Sanger (Dideoxy) chain termination method. Which of the following is found in both methods?
In both methods,

a) dideoxyribonucleoside triphosphates (ddNTP) are used.
b) different fluorescently labelled deoxyribonucleoside triphosphates (dNTPs) are used.
c) the primer is labelled either with radioactivity or with fluorescent molecules.
d) four reaction tubes are required.
e) the labelled products of the sequencing reaction are detected by autoradiography.

125. Cyclic AMP (cAMP)

a) binds to allolactose.
b) interacts with the α-subunits of RNA polymerase.
c) binds to the operator sequence of the lac operon.
d) is at low concentration when glucose is present.
e) inhibits transcription of the lac operon.

126. Which of the following concerning eukaryotic DNA is correct?

a) When eukaryotic genomic DNA is centrifuged on a density gradient, satellite DNA is found in the same band as DNA containing tandemly-repeated genes.
b) Tademly-repeated genes are considered to be non-functional spacer DNA.
c) In a given organism, the DNA nucleotide sequence of individual genes coding for 18S rRNA is highly variable.
d) The property of microsatellites that is exploited in DNA fingerprinting is the variability in the DNA nucleotide sequence of microsatellites in different individuals.
e) The Aγ and Gγ genes are most susceptible to cleavage by DNases during the fetal
stage of human development.

127. The following shows the ends of a piece of DNA that you would like to amplify using the polymerase chain reaction. Which of the following are the correct set of primers that you should choose?

5’ ACC CCC TCC AGA ----------GGG CCA GCG TAT 3’
3’ TGG GGG AGG TCT ---------- CCC GGT CGC ATA 5’

a) Forward = 5' ACC CCC TCC AGA 3', reverse = 5'ATA CGC TGG CCC 3'
b) Forward = 5' AGA CCT CCC CCA 3', reverse = 5' CCC GGT CGC ATA 3'
c) Forward = 5' TTG GGG AGG TCT 3', reverse = 5' TAT GCG ACC GGG 5'
d) Forward = 5' AAA GGG CCA GCG 3', reverse = 5' TTT CGG AAG TCT 3'
e) Forward = 5' GGG CCA GCG TAT 3', reverse = 5' TCT GGA GGG GGT 3'

128. Which of the following is a feature of chromatin?

a) Moderate digestion of chromatin with DNases yields amino acids and deoxyribonucleotides.
b) Chromatin is found in its most condensed form in mitosis.
c) Histones are the only proteins found in chromatin.
d) A histone 2A and 2B dimer is found in the linker region of chromatin.
e) DNA that is actively being transcribed exists in cells as heterochromatin.

129. The solenoid structure of chromatin forms when

a) double-stranded DNA forms supercoils.
b) double-stranded DNA wraps around the core histones.
c) nucleosomes form a spiral shape with 6 nucleosomes per spiral.
d) scaffold proteins attach to form a highly condensed form of chromatin.
e) Chromatin is isolated in low (non-physiological) salt conditions.

130. Which of the following would you expect to happen if a mutation was made so that all of the lysine residues in yeast histones were converted to glycine?

a) The histone acetylase, Gnc5, would not bind to Gnc4.
b) Ume6 would not bind to URS-1.
c) The amount of acetylation on histone would be increased.
d) Transcription of genes controlled by Gnc4 would decrease.
e) Gnc4 would not bind to UAS.

131. Which of the following is NOT a modification that is made to histones?

a) Acetylation of lysine residues.
b) Ubiquitination of lysine residues.
c) Methylation of lysine residues.
d) Acetylation of arginine residues.
e) Phosphorylation of serine or tyrosine residues.

132. A Northern blot would be performed to determine if a group of cells

a) express RNA with a specific nucleotide sequence.
b) have RNA.
c) have DNA.
d) express a specific protein.

e) have a gene with a specific nucleotide sequence.

133. Which of the following statements describes a DIFFERENCE between the structure of DNA and RNA?

a) The 3' end of RNA has a hydroxyl group on carbon 3'.
b) In DNA, the nitrogenous bases can be cytosine, uracil, guanine, and adenine.
c) In RNA, the nitrogenous base is attached to carbon 1'.
d) In DNA, these is no hydroxyl group attached to carbon 2'.

134. You wish to amplify some DNA and notice that there is a high content of G and C at the ends of the sequence. You should increase the temperature in which step of the polymerase chain reaction?

a) Synthesis.
b) Termination.
c) Denaturation (melting).
d) Annealing.

135. Which is INCORRECT concerning the over-all structure of the B-form DNA?

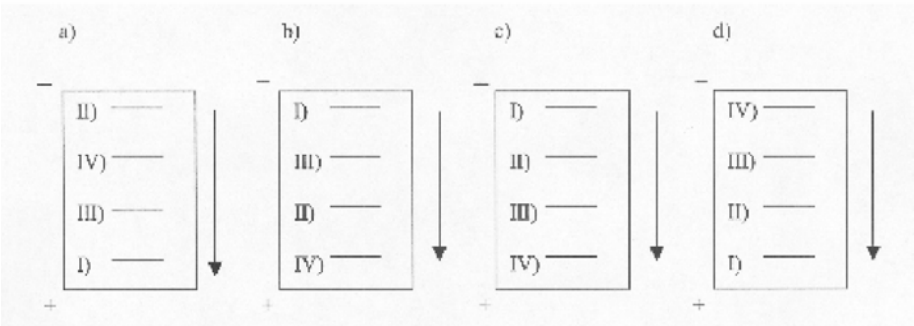
a) It is the naturally occurring form in tissues.
b) It is a right-handed helix.
c) It is a left-handed helix.
d) It consists of ten base pairs per turn.

136. Choose the CORRECT statement

a) The Tm (melting temperature) of DNA is decreased with increased salt conditions.
b) Proteins interact with the base pairs via the major and minor grooves.
c) Ethidium Bromide interacts with the phosphate groups of dsDNA.
d) Covalent bonds between base pairs help to stabilize the dsDNA **Which of the following electrophoresis gels accurately represents the way in which the given DNA fragments would run on the gel?**

I) 5' - A - C - 3'
II) 5' - A - C - T - G - T - 3'
III) 5' - A - C - T - 3'
IV) 5' - A - C - T - G - 3'

a) II, IV, II, I
b) I, III, II, IV
c) I, II, III, IV
d) IV, III, II, I



137. What is the function of the nucleolus?

a) The site where cellular rRNA is made.
b) The site of transcription by RNA polymerase II.
c) The region in prokaryotic cells where DNA is found.
d) The region in eukaryotic cells where simple sequence DNA is found.
e) The region in the eukaryotic nucleus where RNA splicing occurs.

138. DNA is held together by hydrogen bonds, hydrophobic interactions, ionic bonds and van der Waals interactions. What is a van der Waals interaction?

a) A noncovalent bond in which one atom donates and electron to another atom.
b) A covalent bond in which there is a sharing of electrons in the outer shell.
c) A noncovalent bond involving oppositely charge dipoles.
d) An aggregation of nonpolar molecules surrounded by highly ordered water molecules.
e) A covalent bond involving a hydrogen atom and a carbon atom.

139. **Which of the following statements describes a SIMILARITY between the structure of DNA and RNA?** In both DNA and RNA,

a) the nitrogenous base uracil is found.
b) there is a hexose sugar.
c) the carbon 3' is bound only to hydrogen.
d) the carbon 2' has an hydroxyl group.
e) the nitrogenous base is attached to carbon 1'.

140. Guanosine

a) is used by DNA polymerase for the synthesis of DNA.
b) consists of guanine, deoxyribose, and one or more phosphates.
c) is used by RNA polymerase in the synthesis of RNA.
d) can also be called guanylate.
e) consists of guanine and ribose.

141. Proteins of interest are frequently tagged with green fluorescent protein. In many cases addition of GFP does not alter the function of protein of interest. What is the most likely explanation for this observation?

a) GFP consists of a helix-loop-helix motif that binds to DNA when it enters the nucleus.
b) GFP only has primary protein structure, so the tertiary structure of the protein of interest is not altered.
c) GFP is always attached to the N-terminal end of the protein of interest.
d) Proteins consist of functional and structural domains that fold and function as modular units.
e) GFP-tagged proteins can be made and can act in living cells.

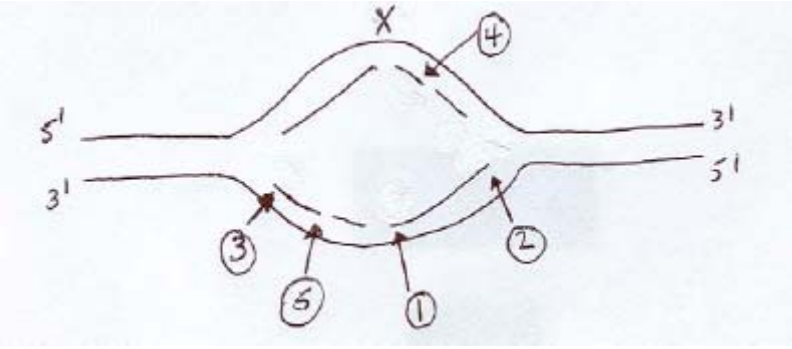
142. Which of the following concerning DNA replication in prokaryotes is CORRECT?

a) DNA polymerase III moves towards the 5' end of the template strand.
b) Telomerase is required to add nucleotides to the 3'end of the lagging-strand template.
c) Deoxyribonucleoside monophosphates are used as substrates.
d) The hydrogen on carbon 2' of deoxyribose reacts with the nucleotide.
e) The synthesis of the leading strand is discontinuous.

143. What is the percentage of adenines in a piece of RNA if the percentage of cytosine is 30%?

a) 30%
b) 20%
c) 60%
d) 40%
e) Unable to calculate with the information provided.

144. In diagram below illustrating DNA replication which numbers represent the 5' end of the single-stranded DNA. X = origin of replication.



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

145. The following are steps involved in DNA replication of eukaryotic genes. **Put the steps in the CORRECT order.**

1) Primase synthesizes primers composed of RNA.
2) MCM helicases unwind double-stranded DNA
3) DNA polymerase α synthesizes DNA.
4) Replication protein A (RPA) proteins bind.
5) Replication factor C (Rpc) binds.
6) T antigen unwinds double-stranded DNA.
7) DNA polymerase δ synthesizes DNA.
8) Ribonuclease I and FENI remove RNA.

a) 2, 4, 1, 3, 5, 7, 8
b) 6, 5, 1, 3, 4, 7, 8
c) 1, 2, 3, 4, 5, 6, 8
d) 2, 5, 1, 7, 4, 3, 8
e) 6, 5, 1, 7, 4, 3, 8

146. Which of the following statements concerning DNA replication in prokaryotes and eukaryotes is CORRECT?

a) Discontinuous DNA synthesis of the lagging strand occurs in prokaryotes but not in
eukaryotes.
b) Single-strand binding protein and replication factor C (Rfc) both bind to single-stranded
NA to prevent complementary base pairing. D
c) In both prokaryotes and eukaryotes only one type of DNA polymerase is required to
synthesize the daughter strands.
d) The τ-subunit of DNA polymerase III and PCNA in eukaryotes make DNA polymerase rocessive. p
e) DNA polymerase I in prokaryotes and DNA polymerase δ in eukaryotes fill in the gap left by removal of RNA.

147. A sequence of an RNA template found in telomerase is: 5'UAGGGUAGGGUAGGG3'

Which diagram represents the correct sequence of one of the ends of a chromosome taken from the same cell as the telomerase? The "---" represents the middle part of the

chromosome.

a) ----------TAGGGTAGGGTAGGG3’
----------ATCCCATCCCATCCC5’
b) ---------- ATCCCATCCCATCCC 3’
----------TAGGGTAGGGTAGGG 5’
c) ---------- CCCTACCCTACCCTA3’
----------GGGATGGGATGGGAT5’
d) ---------- GGGATGGGATGGGAT3’
---------- CCCTACCCTACCCTA 5’
e) none of the above.

148. Which CORRECT statement can be made concerning DNA replication or transcription in prokaryotes?

a) A DNA primer is required for DNA replication of the bacterial chromosome.
b) RNA polymerase starts to transcribe from the TAC triplet on the template strand.
c) A helicase is used to unwind DNA into single strands in transcription.
d) A sigma factor directs the core RNA polymerase to the start site of transcription.
e) The entire chromosome is copied in DNA replication and in transcription.

149. Which of the following statements is CORRECT?

a) Prokaryotic genomes have lots of spacer DNA.
b) Many genes devoted to a single metabolic pathway are found within complex transcriptional units in prokaryotes.
c) Once the sequence of the human genome was known the function of all human proteins became known.
d) Eukaryotic chromosomes consisting of DNA and proteins are circular.
e) Genes in prokaryotes and eukaryotes always code for proteins.

150. Which of the following is NOT a function of RNA?

a) It acts a peptidyltransferase during translation.
b) It is required for RNA splicing.
c) It is essential for the structure of ribosomes.
d) It attaches the correct amino acid to tRNA.
e) It recognizes the Shine-Dalgarno sequence.

151. Which reading frame on the following mRNA would code for the longest full-length peptide?
5’CCUGAUGCAUGCCUAGAUGCCAUAACGGGCUUAAAUAGAUGA3’

a) First.
b) Second.

c) Third.
d) First and second.
e) Second and third.

152. **What is the name of the region between the start codon and 5' end of prokaryotic mRNA?** The

a) 3' untranslated region.
b) start site for translation.
c) 5' untranslated region.
d) polyadenylation signal.
e) promoter.

153. Which of the following is required for the initiation of translation in prokaryotes?

a) Hydrolysis of GTP bound to initiation factor 2 (IF2).
b) The addition of a methyl group to the methionine attached to $tRNA_{i\ met}$.
c) The Shine Dalgarno sequence base pairs with the 5' end of the mRNA.
d) The binding of RF1 to the stop codon on the mRNA.
e) f-met- $tRNA_{imet}$ binding to the A site on the ribosome.

154. Which of the following statements concerning aminoacyl-tRNA synthetase is correct?

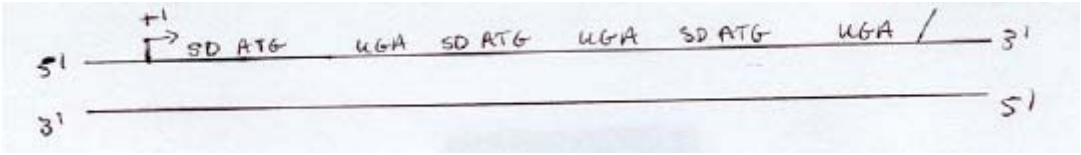
a) The activity of these enzymes is enhanced in the presence of EF-Tu.
b) These enzymes have proofreading activity to ensure that the correct amino acid is
attached to tRNA.
c) These enzymes are responsible for removing the polypeptide from the tRNA at the end of translation.
d) These enzymes also have peptidyltransferase activity and are found in the large subunit of the ribosome.
e) These enzymes attach amino acids to the C1' hydroxyl group of the ribose at the 3' end of tRNA.

155. What is the most direct technique to determine if cells express RNA that codes for a specific protein?

a) Purify RNA from the cells, cut the RNA with a restriction enzyme, run the digest on a gel and look for a band of the appropriate size. a
b) Purify RNA from the cells, run it on a gel, transfer the RNA to a membrane and probe with DNA complementary to the RNA you are interested in.
c) Purify the specific RNA from the cells and do a polymerase chain reaction with specific primers.

d) Purify RNA from the cells, run it on a gel and look for a band of the appropriate size.
e) Purify DNA from the cells, run it on a gel, do a Southern blot and probe with DNA complementary to the RNA you are interested in.

156. **Which of the following would be produced upon transcription and translation of the following operon?** SD = DNA coding for the Shine Dalgargo sequence.



a) One mRNA with one start codon and one stop codon and 3 polypeptides.
b) One mRNA with three start codons and three stop codons and 3 polypeptides.
c) Three mRNAs each with a start and stop codon and 3 polypeptides.
d) Three mRNAs with one start and one stop codon and 1 polypeptide.
e) None of the above.

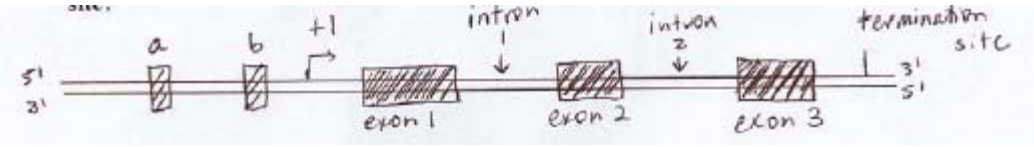
157. **Which of the following describes a SIMILARITY in the processes that occur during the polymerase chain reaction and DNA replication?** In both cases,

a) deoxyribonucleotides are added to the 3' end of RNA primers.
b) the double-stranded DNA separates due to the action of helicases.
c) all of the DNA present in the sample or in the cell is copied.
d) polymerization of nucleotides occurs at 95 C.
e) the synthesis of DNA is semi-conservative.

158. Which of the following statements concerning transcription of the pre-rRNA gene in eukaryotes is CORRECT?

a) To make sufficient rRNA, transcription is carried out by all three types of RNA polymerases.
b) Ribonucleases cleave pre-RNA to produce 18S, 5.8S and 28S.
c) rRNA is translated by ribosomes.
d) The pre-rRNA gene contains introns with GU at the 5' end and AC at the 3' end.
e) The pre-rRNA gene contains three open reading frames.

159. The diagram below depicts a simple transcriptional unit with two control regions labelled "a" and "b" and three exons and two introns. What would happen if a mutation occurred in the middle of intron #2, which introduced a 5' end of a splice site?



a) This transcriptional unit would **not** be transcribed.
b) The mRNA that was produced would **not** bind to the small ribosomal subunit.
c) An mRNA encoding a non-functional protein may be produced.
d) Intron #1 would remain in the mature mRNA.
e) The regulation of transcription termination would be lost.

160. Which of the following is a feature of chromatin?

a) Moderate digestion of chromatin with DNases yields amino acids and deoxyribonucleotides.
b) DNA that is actively being transcribed exists in cells as heterochromatin.
c) Histones are the only proteins found in chromatin.
d) Chromatin is found in its most condensed form in interphase.
e) Regions of DNA that contain methylated cytosine are less likely to be transcribed.

161. **What is meant by the histone code?** It refers to

a) the sequence of ribonucleotides that code for each type of histone.
b) histone modifications to which specific proteins bind, thereby altering transcription.
c) the high degree of homology between all types of histones.
d) the observation that the genes coding for histones are tandemly repeated genes.
e) the specific sequence of deoxyribonucleotides that code for each type of histone.

162. What is the purpose of adding ethanol during DNA isolation?

a) It denatures proteins so that they are not precipitated with DNA at the end.
b) It replaces the water molecules near the DNA, and as a result of hydrophobic interactions, the DNA becomes insoluble in an aqueous solution and can be precipitated
c) It maintains the osmotic pressure and pH of the solution.
d) It neutralizes the ionic interactions between DNA and histones so the DNA does not
precipitate out of solution with the protein.
e) It chelates Mg^{2+} ions thereby reducing the activity of many nucleases and preventing
DNA degradation.

163. The following picture represents the volume setting of a P1000 micropipettor. What volume of fluid will be delivered if the pipettor is used correctly?

a) 350 µl
b) 35 µl
c) 3.5 µl
d) None, setting the volume as shown will break the pipettor.
e) An indeterminate amount since this setting is outside of the range of this pipettor.

164. Which of the following statements concerning the structure of DNA is CORRECT?

a) Thymine is a purine that makes three hydrogen bonds with adenine.
b) The nitrogen 1 of purines is bonded to the carbon 1' of deoxyribose.
c) The free carbon 3' end of DNA has a phosphate group attached.
d) Uracil is covalently attached to the carbon 1' of deoxyribose.
e) Guanine is a purine that makes three hydrogen bonds with cytosine.

165. Restriction enzymes have been isolated from bacteria, algae, fungi and other organisms and act as a defense system against foreign DNA. How are the genomes of these organisms protected against their own restriction enzymes?

a) The restriction enzymes are produced in the cytoplasm and do not have access to nuclear DNA.
b) The specific sequences recognized by the restriction enzymes are not found in the genome of the organism.
c) Bases in the DNA of the organisms are methylated and methylated bases are not
recognized by the restriction enzymes.
d) DNA in the organisms is packaged with proteins that protect the DNA from cleavage by the restriction enzymes.
e) An inhibitor protein binds to the restriction enzymes keeping the enzyme inactive until it encounters foreign DNA.

14.18 Practice Short Answer Questions

166. Define lagging strand.

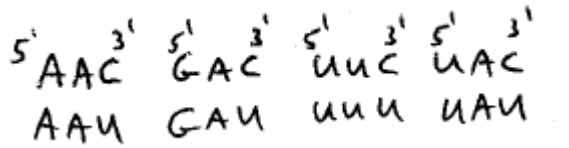
Answer:

The strand in DNA synthesis that cannot be continuously synthesized in the 5' to 3' direction. Must be made as a series of fragment, each primed by an RNA primer as the replication fork grows

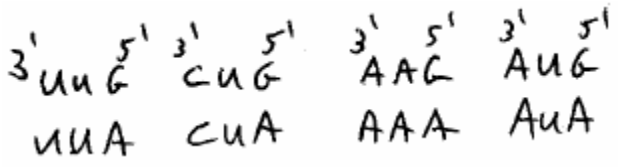
167. Suppose an organism was discovered on Mars whose genetic code was identical to Earth's standard genetic code except that there was never an A or a U in the third position of a codon. The amino acid sequence of a portion of a protein from the Martian organism was found to be:

- asn-asp-phe-tyr-

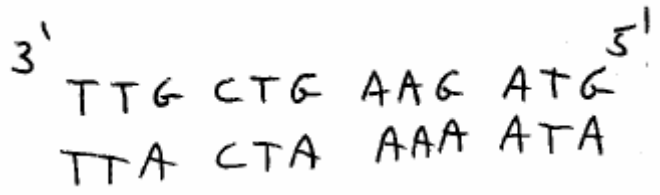
- List in order, the codons that give rise to this portion of the protein and indicate the 5' and 3' ends of each codon



- List in order, the anticodons of the tRNAs that decipher the codons, and indicate the 5' and the 3' ends of each anticodon



- Give the sequence of the portion of the transcribed strand of DNA that encodes these four amino acids. Indicate its 5' and 3' ends



168. Transcription occurs spontaneously and does not require any energy to power the process

Answer:

False. The reaction of removing two phosphate from the nucleoside triphosphate as they are inserted into the growing RNA chain power the process

169. What are two of the ways in which eukaryotic mRNA is different from prokaryotic mRNA?

Answer:

5' Cap, poly(A) tail, removal of introns, no multiple open reading frames, longer half life, made in nucleus, not translated until transcription is complete, etc.

170. Why are very high doses of aspirin (acetyl salicylic acid) toxic?

Answer:

It shuttles protons across the inner mitochondria membrane which uncouples cellular respiration.

171. Name two of the enzymes required for DNA synthesis.

Answer:

Primase, DNA Polymerase (there are several types), Ligase, Helicase, Single strand binding proteins.

172. Why can't eukaryotic cells replicate by binary fission?

Answer:

Eukaryotes have several large chromosomes inside a nucleus so they must use mitosis to segregate the chromosomes to each pole of the cell prior to cytokinesis.

173. What are two ways in which normally harmless bacteria may acquire genes which make them pathogenic?

Answer:

Acquire a plasmid by conjugation (e.g. anthrax), infection by a prophage (e.g. botulinum toxin), transformation (e.g. S type of *S. pneumoniae*).

174. What are two of the methods cells use to regulate biochemical reactions?

Answer:

Regulate gene transcription and enzyme activity are just two examples.

175. What two roles do microtubules perform during mitosis in an animal cell?

Answer:

Move chromosomes and elongate the cell.

176. The following represents the normal nucleotide sequence of a small stretch of human DNA. It contains the coding sequence (open reading frame) for the protein hormone vasopressin, a 10 amino acid long protein. It is written 3' to 5'; the promoter (not shown) is to the left and the transcription termination signal (not shown) is to the right.

3'AATTATACACGATGAAG**C**TTGTGACAGGGTTACCAATCA-5'

normal mRNA & protein
5'UUAAUAUGUGCUACUUCGAACACUGUCCCAAUGGUUAGU

MetCysTyrPheGluHisCysProAsnGlyTer

altered mRNA & protein

5'----------UAA----------
MetCysTyrPheTer

I have used the proper three letter abbreviations for the amino acids (it is not necessary that you know the full names). Note that "Ter" is translation termination not an amino acid.

a) Is this the **template** or the non template strand?

b) Write the sequence of mRNA made from this entire stretch of DNA. (see above for answer)

c) Use the given genetic code to write the amino acid sequence of the vasopressin protein.

d) If a mutation changed the nucleotide indicated in red from a C to an A would the vasopressin gene still make a functional protein? Why or why not?

No, the protein is truncated and be unlikely to function.

177. What are two of the differences between RNA and DNA?

Answer:

There are several including the sugar, the choice of bases, the stability, the length, double vs. single stranded, the location in eukaryotic cells, the function, etc.

178. Name and describe one internal and one external signal that can halt the eukaryotic cell cycle.

Answer:

Internal: insufficient size, unfavorable environment, presence of Okazaki fragments, unattached chromosomes at the metaphase plate.

External: growth factors, density-dependent inhibition, anchorage dependence.

179. Given the RNA sequence

1 5 10 15 20
AUG GUU GCU UCG ACG CCC UAA

What peptide could this encode?
What would happen if a mutation changed U at position 6 to C?
What would happen if a mutation changed A at position 13 to G?
What would happen if a mutation changed C at position 11 to A?
What would happen if a mutation inserted a C between position 5 & 6?
What would happen if an A was inserted between position 7 & 8 and residue number 15 was deleted?

Can you begin with the gene for any protein in the nucleus and explain the sequential steps involved in:

a) converting the gene into mature mRNA (transcription and RNA processing),

b) converting the mature mRNA into the protein (protein synthesis) and

c) targeting of the protein to its final destination in the cell ???

Consider all possible destinations in the cell.....the nucleus, the peroxisome, the mitochondrion, the chloroplast, the lysosome, the ER, the Golgi, the plasma membrane, the endosome, the cytoplasm (for example, cytoskeleton proteins, signaling proteins, proteins involved in protein synthesis, ribosomal proteins etc.)

180. Use the genetic code (look up code table in the text) to answer the following questions:

a) Indicate the sequence of the transcription and translation products of the following piece of DNA in the nucleus. Assume there are no introns present.

3'U TACCAATTGGATTCTTACTATTTTATAATC 5'U (template strand)

5'U ATGGTTAACCTAAGAATGATAAAATATTAG 3'U

b) If an identical piece of DNA were also present in the mitochondrion of this mammalian cell, would it have identical transcription and Translation products? Explain in detail.

c) Name the exact compartments in the cell in which the nuclear and mitochondrial transcription and translation products are made.

d) Now, assume that the nuclear DNA does have introns as indicated below

3'U TACCAA(intron)TTGGATTCT(intron)TACTATTTTATAATC 5'U (template)

5'U ATGGTT(intron)AACCTAAGA(intron)ATGATAAAATATTAG 3'U

e) Describe the processing of the precursor messenger RNA transcribed from this DNA shown above

f) Starting with the mature messenger RNA in the nucleus derived from the above gene, indicate in detail the steps leading to the synthesis of the protein product represented by this messenger RNA and how the protein is sent to its final destination in the cell.

181. Fill in the blanks

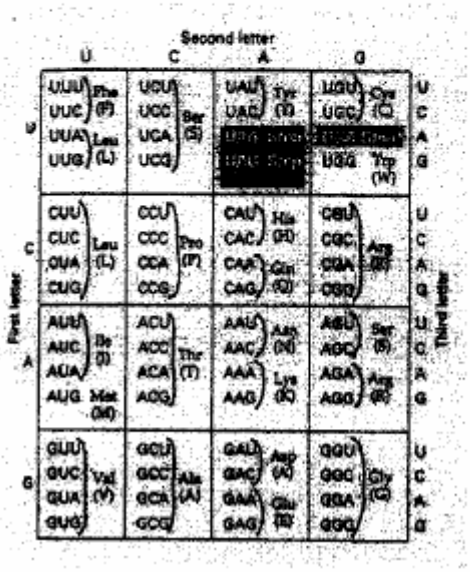
- The process by which bacteriophage sometimes transfer DNA from one *E. coli* to another is called **transduction**
- Regions of DNA in interphase cells that are not expressed and are as condensed as chromosomes during mitosis are called **heterochromatin**
- "Nicks" in a DNA strand can be sealed by the enzyme **DNA ligase**
- In eukaryotes, RNA polymerase I synthesizes **ribosomal RNA or rRNA**
- The process by which introns are removed from eukaryotic RNAs is called **splicing**
- The antibiotic **tetracycline** inhibits binding of charged tRNAs to bacterial ribosomes

182. Match the following

3	Assignment of specific codons to specific amino acids	1. M. Messelson
9	The genetic code is a triplet code	2. W. Saruman
7	The chemiosmotic hypothesis	3. M. Nirenberg
1	Semi-conservative replication of DNA	4. M. Calvin
5	Structure of DNA	5. J. Watson
6	DNA is the genetic material	6. O. Avery
		7. P. Mitchell
		8. S. Holmes
		9. S. Brenner
		10. C. Yanofsky
		11. B. Baggins
		12. P. Esposito
		13. R. Okazaki
		14. A. Kornberg

183. Rules: this organism uses codons that have C or G as the third base in the codon Indicate 5' or 3' at the start and the end

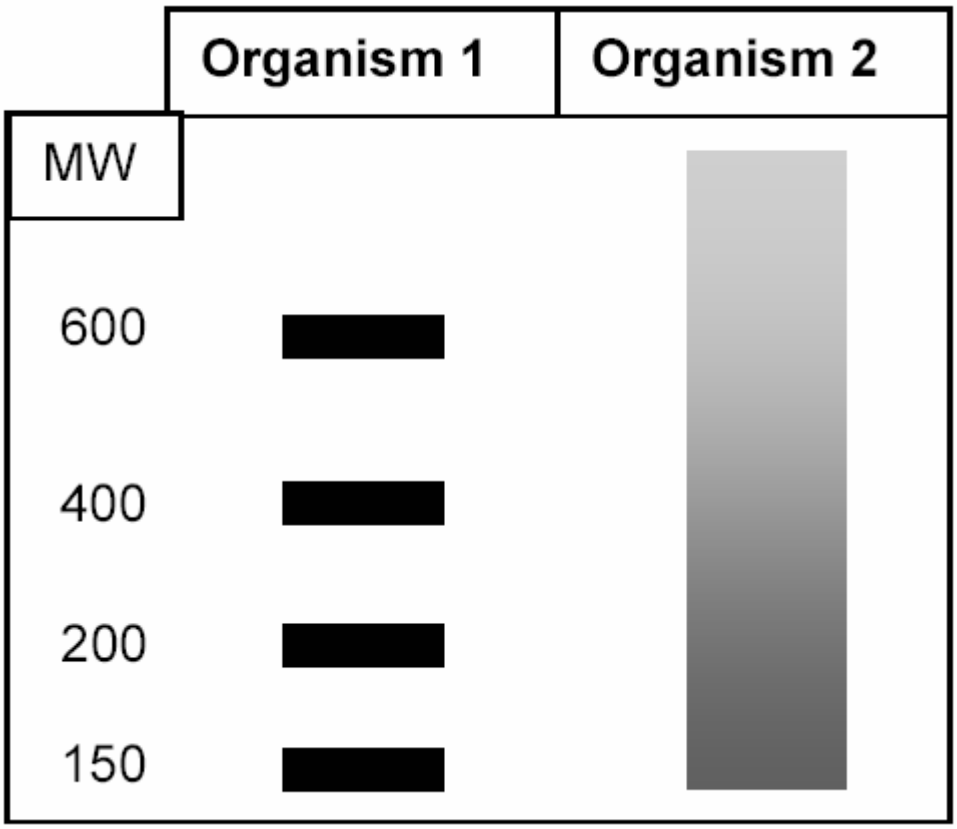
Sequence of the transcribed DNA strand	5' or 3'	TAC	TTG	TTC	ATC	5' or 3'
Sequence of codon in mRNA	5' or 3'	AUG	AAC	AAG	UAG	5' or 3'
Sequence of anticodon	5' or 3'	UAC	UUG	UUC	—	5' or 3'
Amino acids specified in protein	NH_2 end	Met	Asn	Lys	Stop	COOH end



Draw a diagram of the chromosomes of a cell in metaphase of mitosis in an organism in which 2n=6. In your diaram label one of each of each of the following: chromatid, centromere, and chromosome

184. You want to explore DNA packing in two different species. You do the following experiment:

1. Briefly digest chromatin from two different species with nuclease
2. Remove associated proteins
3. Separate DNA molecules by size using gel electrophoresis



185. Which organism would you identify as a prokaryote based on these results? Explain why in 1-2 sentences.

Organism 2 is a prokaryote because its DNA is readily cut by the nuclease throughout its sequence, resulting in DNA fragments of all sizes. If DNA were bound to proteins, the bound DNA sequences would be resistant to cutting by the nuclease, and this would result in bands of discrete sizes on a gel.

186. The following is the actual sequence of a small stretch of human DNA:

5’-TTAATATGTGCTACTTCGAACACTGTCCCAAAGGTTAGTAATT-3’
3’-AATTATACACGATGAAGCTTGTGACAGGGTTTCCAATCATTAA-5’

(a) What are the two possible RNA sequences that could be transcribed from this DNA? Indicate the 5’ and the 3’ ends of the RNAs.

3’-AAUUAUACACGAUGAAGCUUGUGACAGGGUUUCCAAUCAUUAA–5’

5’-UUAAUAUGUGCUACUUCGAACACUGUCCCAAAGGUUAGUAAUU–3’

187. If an *E. coli* protein is 200 amino acids long, how long would you expect its mRNA to be? Its gene? Explain your answer.

The mRNA would have an open reading frame that is 600 nt long (200 codons x 3 nt/codon). There would also be a short leader and trailer. Thus the mRNA length would be about 650 nt. Its gene would contain the transcribed region of the DNA plus the promoter region. Say about 750 bp long in total.

188. The average human protein is 450 amino acids long. How long would you expect the average human mRNA to be? The average human gene? Explain your answer.

The mRNA would have an ORF of 1350 nt plus the leader plus the trailer plus the poly(A) tail. The actual answer is 2400 nt. The gene would be significantly longer because of the promoter and the introns. The average human gene is 27 000 bp and has 9 exons and 8 introns.

189. This is an actual sequence of human DNA. It contains the open reading frame for the protein vasopressin, a 10 amino acid long hormone. It is written 3' to 5'; the promoter (not shown) is to the left and the transcription termination signal (not shown) is to the right.

DNA 3'-AATTATACACGATGAAGCTTGTGACAGGGTTACCAATCA-5'
RNA 5'-UUAAUAUGUGCUACUUCGAACACUGUCCCAAUGGUUAGU-3'
Protein MetCysTyrPheGluHisCysProAsnGlyTer

a. Is this the template or the non-template strand? Template
b. Write the sequence of mRNA made from this entire stretch of DNA. See above
c. Use the genetic code to write the amino acid sequence of the vasopressin protein. See above – note that Ter is not an amino acid, it is the abbreviation for termination.
d. If a mutation changed the nucleotide indicated in bold from a C to an A, would the vasopressin gene still make a functional protein? Why or why not?

The codon would be changed from GAA (Glu) to UAA (Stop). This change is therefore a nonsense mutation and it would be unlikely that the truncated protein would be functional.

190. Describe the characteristics of a cancerous cell.

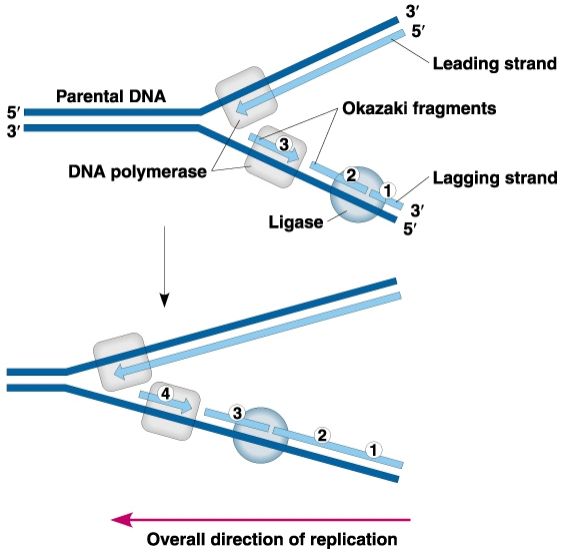
They exhibit uncontrolled growth because of autocrine stimulation and/or lack of apoptosis and/or lack of cell-to-cell communication and/or loss of contact inhibition.
They carry multiple mutations in several genes. This is often evident upon karyotype as translocations, duplications, aneuploidy etc.

They exhibit metastasis, meaning they can dissociate from surrounding cells and be relocated somewhere else in the body.
They can encourage angiogenesis that is necessary for growth into a tumor.

191. What is a protooncogene? How does it become an oncogene?

It is a wildtype gene that has been identified as being involved in cancer when it mutates. It is not involved in cancer in its normal wildtype form. Once it has mutated it becomes an oncogene. This can happen by the insertion of a viral promoter upstream of the coding region that drives expression of the gene in non-normal levels (too much or too little). Sometimes the virus excises and carries the oncogene with it. An example of this would be oncogenes carried by human papilloma virus that causes cervical cancer. It can also happen to by environmental mutagens that change the DNA sequence such that the product is no longer functioning normally. An example of this would be the formation of the RAS oncogene from the RAS protooncogene.

192. Draw a molecule of DNA undergoing eukaryotic linear replication. On your drawing, identify (1) origin, (2) polarity (5' and 3' ends) of all template strands and newly synthesized strands, (3) leading and lagging strands, (4) Okazaki fragments, and (5) location of primers.



193. What are the wobble rules?

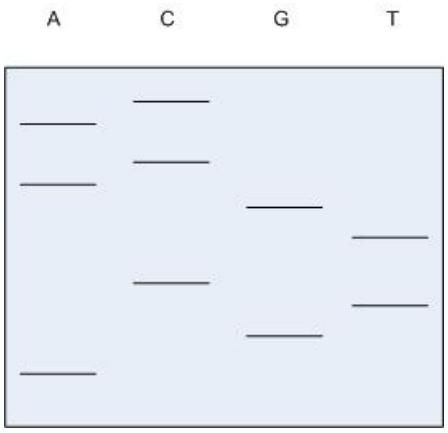
If the nucleotide at the 5' end of the anticodon is G, it can bind with U or C.
If the nucleotide at the 5' end of the anticodon is C, it can bind with G only.
If the nucleotide at the 5' end of the anticodon is A, it can bind with U only.
If the nucleotide at the 5' end of the anticodon is U, it can bind with A or G.

If the nucleotide at the 5' end of the anticodon is I, it can bind with U, C or G. This contributes to the redundancy in the genetic code. In other words, wobble allows more than one codon to code fore the same amino acid.

194. Explain how translation of the mRNA 5'.....AUGCUCUACGGUUAG….3' (only the coding sequences are shown) would be carried out by the ribosome.

- small subunit binds to the AUG start codon downstream of the Shine-Dalgarno sequence in prokaryotes and in eukaryotes, downstream of the 5' cap
- this brings in N-formyl methionine-charged tRNA in prokaryotes and methionine-charged tRNA in eukaryotes
- the binding is through recognition of the anticodon on the tRNA for the codon on the mRNA
- the large subunit now binds to the complex such that the first charged tRNA is in the peptidyl position
- the next charged tRNA binds to the aminoacyl site by codon/anti-codon base pairing
- peptidyl transferase forms peptide bond between the amino acid (COOH from P amino acid and NH_2 from A)
- in doing so, it transfers the first amino acid onto the second amino acid (in the A site)
- the first tRNA in the P site now dissociates from the ribosome and the tRNA from the A site, carrying the growing polypeptide chain, now moves into the P site
- this allows for the next charged tRNA to enter the A site
- the cycle continues until a nonsense codon (stop) is reached at which point a release factor enters the A site and the entire complex dissociates, releasing the polypeptide
- the amino acid sequence should be met leu tyr gly

195. From the autoradiograph of a sequencing reaction shown below, determine the sequence and the polarity of the <u>template</u> strand.



Determine the newly synthesized strands from the gel first. Since the fragments at the top of the gel are longest, they would represent the 3' end of sequence. The fragments at the bottom of the gel represent the shortest and therefore are at the beginning of the sequence (5' end). The sequence from top to bottom therefore reads 3' CACAGTCTGA 5'. Since this sequence represents the newly synthesized strands, then the template would be the opposite (complimentary). The template therefore reads 5' GTGTCAGACT 3'.

196. A chromosome initially has the following segments: A B C D E F G

Draw and label the chromosome that would result from each of the following mutations:

A.
a) Tandem duplication of DEF: A B C D E F D E F G.
b) Deletion of FG: A B C D E.
c) Deletion of CD: A B E F G.
d) Paracentric inversion that includes DEFG: A B C G F E D.
e) Pericentric inversion of BCDE: A E D C B F G.

197. Compare and contrast retroposons and transposons.

A. They are both types of transposable elements which are small segments of selfish DNA that can move around the genome. Retroposons are characterized by requiring an RNA intermediate for their replication and subsequent insertion into the genome. They need reverse transcriptase to do this, however not all retroposons encode their own reverse transcriptase, some rely on other retroposons to make it. Retroposons can be recognized as having poly A sequences at one end or having long terminal repeat sequences at each end. Transposons do not use an RNA intermediate. They rely on production of a transposase to cleave themselves out of the genome and reinsert in a different spot. They, like some retroposons have repeat sequences at their ends.

198. Contrast and compare transcription in prokaryotes and eukaryotes using the chart below.

	Prokaryote	***Eukaryote***
Cellular compartment	Cytoplasm	Nucleus
Promoter	-10 TATAAT, -35 TTGACATGC- rich region	-30 TATA(A/T)A(A/T), -100 CCAAT, -200 Enhancer elements further upstream

RNA polymerase	σ factor + core enzyme = holoenzyme, σ factor required for initiation. Recognizes -10 and -35 consensus sequences	Three types I (rRNA), II (structural), III (tRNA). Requires TBP and other basal factors as well as activators
Post-transcription processing	None	Methylated 5' guanosine cap addition of poly A tail removal of intron sequences alternative and/or trans-splicing

199. Underline the following sequences in the coding strand of the gene shown below:

Start and stop of translation
Promoter consensus sequences
Intron sequences (if any)
Is this a prokaryotic or a eukaryotic gene? Give reasons.

It is eukaryotic as it has no Shine-Dalgarno ribosome binding consensus. Also it contains promoter elements characteristic of eukaryotes and appears to contain an intron (which prokaryotes don't have)

5'gagaaagggaatttcatccaatacaaggcttgcagtctggctccggctgacggtccgcgacctcgctgtccgggctcctgttt
ctctccgccgcgctctcgctctggccgacgagtataaattaatctgcgggccaggcatcgacatccgcaacgactatcagcagc
tgaagcgcctggagaatggcagagtggtcgagggctacactgaccatcctgctcatccccttctcttctagaaggccgaggact
accgcagctaccgcttccccaagctcacggtcattaccgagtacttgctgctgttccgagtgtctggcctcgagactgagcctcg
gatttgtgttagttcagtctcaaccgtcagtcatgaaataaatgattcatt…