Bio104 Molecular Biology Name _____

Exam 1 Spring 2010

Multiple choice (1 pt each)

1. Which of the following statements best describes Chargaff's Rules?
a. based pairs in DNA interact through hydrogen bonds
b. in the DNA of any organism the mass of cytosine equals the mass of guanine and the mass of thymine equals the mass of adenine.
c. The DNA of all organisms encodes polypeptides in the same manner. The genetic code is universal.
d. The strands of DNA in the double helix run antiparallel relative to each other.
e. None of the above are correct

2. A gene
a. is a length of DNA
b. encodes a polypeptide
c. has a promoter that controls the rate of transcription of the gene
d. all of the above are correct
e. only a and c are correct

3. The -10 and -35 sequences found in the promoters of prokaryotic genes function to
a. bind RNA polymerase and position it to start transcription at the +1 position of the gene
b. bind repressor proteins that inhibit transcription
c. position ribosomes at the start of translation
d. signal the termination of DNA replication
e. facilitate the transposition of transposons

4. A codon
a. is a nucleotide triplet
b. specifies a specific amino acid
c. base-pairs with the anticodon of a tRNA during translation
d. all of the above are correct
e. none of the above are correct

5. Strand-directed mismatch repair fixes DNA damage caused by
a. UV light
b. Ionizing radiation
c. Replication errors
d. Thermal fluctuations
e. Ethylmethane sulfonate

6. How does the Strand-Directed Mismatch Repair system distinguish the parental strand from the daughter stand so it knows which strand to repair?
a. the parental strands are always 3' to 5'
b. the daughter strands still contain pyrophosphate
c. the parental strands are methylated at GATC sequences
d. the daughter strands have acetyl groups at TATA sequences
e. the parental strands are antiparallel

7. Which of the following enzymes is **not** involved with Strand-Directed Mismatch Repair?
a. DNA polymerase
b. Ligase
c. Endonuclease
d. Helicase
e. Primase

8. Frame-shift mutations change the reading frame used by ribosomes to decode the mRNA and synthesize the polypeptide. Which of the following mutations in the coding region of a gene would introduce a frameshift?
a. a single point substitution of a G for a C
b. a single point substitution of a A for a C
c. deletion of a single nucleotide
d. deletion of 3 consecutive nucleotides

9. Which of the following sequences are complimentary to 5'ATCGCCAA3'
a. 5'ATCGCCAA3'
b. 3'ATCGCCAA5'
c. 5'TAGCGGTT3'
d. 3'TAGCGGTT5'
e. None of the above are correct

10. What reaction is catalyzed by βGalactosidase?
a. the conversion of glucose to lactose
b. the conversion of lactose to maltose
c. the conversion of lactose to glucose plus galactose
d. the conversion of lactose to sucrose
e. the conversion of inducer to repressor

11. What enzyme charges a tRNA with its appropriate amino acid?
a. the ribosome
b. tRNA synthetases
c. rRNA primase
d. permease
e. none of the above are correct

12. The fundamental differences between RNA and DNA include which of the following?
a. RNA contains ribose sugar, while DNA contains deoxyribose sugar
b. RNA is typically single stranded, while DNA is typically double stranded
c. RNA has uracil nucleotides, while DNA has thymine nucleotides
d. All of the above are correct
e. Only a and b are correct

13. Which of the following enzymes functions to break hydrogen bonds and separate the 2 strands of the double helix during DNA replication?

a. DNA Polymerase
b. Ligase
c. Helicase
d. Topoisomeras
e. Primase

14. Which of the following enzymes acts as a swivel and resolves the tangling of the DNA at the replication fork during DNA replication

    a. DNA Polymerase
    b. Ligase
    c. Helicase
    d. Topoisomerase
    e. Primase

15. Which of the following enzymes forms covalent bonds between Okasaki fragments?

    a. DNA polymerase
    b. Ligase
    c. Helicase
    d. Topoisomerase
    e. Primase

16. Which of the following enzymes forms RNA primers?

    a. DNA Polymerase
    b. Ligase
    c. Helicase
    d. Topoisomerase
    e. Primase

17. What is the role of reverse transcriptase in the life cycle of a retrovirus like HIV?

    a. reverse transcriptase converts the virus genome from RNA to double stranded DNA
    b. reverse transcriptase integrates the virus genome into the host chromosome
    c. reverse transcriptase attaches methyl groups to the host chromosome
    d. reverse transcriptase stimulates transposons to jump out of the host genome

18. Catabolite Activator Protein (CAP)

    a. binds to the operator of the Lac operon
    b. functions to recruit RNA polymerase to the promoter and thus stimulates transcription
    c. is activated by c-AMP
    d. all of the above are correct
    e. only b and c are correct

19. When both glucose and lactose exist in E. coli's environment

    a. E. coli metabolizes both sugars equally
    b. E. coli prefers glucose over lactose because it is metabolized faster
    c. E. coli prefers lactose over glucose because it is metabolized faster
    d. The lac Operon is fully derepressed and actively being transcribed
    e. 2 of the above are correct

20. Choose the correct statement with regard to gene regulatory proteins?
    a. they typically bind to DNA as dimers (2 proteins bound to each other)
    b. they gain access to nucleotide bases through the major groove of the DNA helix
    c. they form noncovalent bonds with specific nucleotides
    d. all of the above are correct
    e. none of the above are correct

21. There are 20 different amino acids. They differ from one another in the chemistry of their
    a. carboxyl groups
    b. amino groups
    c. R groups
    d. Peptide

Use one of the following terms to complete statements 22-25. Enter your answers on the scantron.
    a. Peptide bonds
    b. Hydrogen bonds
    c. Ionic bonds
    d. Van der Walls interactions
    e. Phosphodiester bonds

22. The α Helix structure found in many proteins is stabilized by _____.

23. Nucleotides within a strand of DNA are attached to each other by _____.

24. _____ are non-covalent bonds formed by the attraction of hydrophobic molecules for one another

25. A polypeptide is a chain of amino acids linked by _____

26. Allosteric enzymes
    a. Contain an active site that converts reactant to product
    b. Contain an allosteric site to which a regulatory ligand molecule binds
    c. Binding of the regulatory ligand alters the activity of the enzyme
    d. All of the above are correct
    e. None of the above are correct

27. Typically an enzyme interacts with only one type of substrate. What provides the specificity for this interaction?
    a. the enzyme and substrate are both proteins
    b. the enzyme and substrate are oppositely charged
    c. the enzyme and substrate are located within the same compartment in the cell
    d. the enzyme and substrate have complimentary shapes that fit like lock and key
    e. none of the above are correct

28. The component parts of a DNA nucleotide include all of the following **except**
    a. Amino acid group
    b. Phosphate
    c. Deoxyribose sugar
    d. Nitrogenous base

29. What does it mean that DNA replication is semiconservative?
    a. that old recycled nucleotides are used to construct the new daughter strands
    b. that the new DNA helices contain one original parent strand and one new daughter strand
    c. that new daughter strands always contain mutations, thus only part of the original nucleotides sequence is retained
    d. that the parent strand is methylated, but the daughter strand is not

30. New DNA is always synthesized in the _____ direction.
    a. 5' to 3'
    b. 3' to 5'
    c. 3' to 3'
    d. 5' to 5'

Match the 4 levels of protein folding with the appropriate definition for questions 31-33. Enter your answers on the scantron.

a. Primary structure
b. Secondary structure
c. Tertiary structure
d. Quaternary structure

31. _____ refers to the formation of α helices and β sheets

32. _____ refers to the sequence of amino acids in the polypeptide.

33. _____ refers to the overall 3D structure of a multi-subunit protein

Match the mutagenizing agent with the type of DNA mutation it causes for questions 34-36. Enter your answers on the scantron.

a. Depurination
b. Deamination
c. Ultraviolet (UV) radiation
d. Ionizing Radiation (Xrays, gamma rays)

34. _____ results in the formation of thymine dimers

35. _____ results in the conversion of a cytosine to a uracil

36. _____ results in the loss of a guanine or adenine base

37. A kinase is an enzyme that functions to
    a. methylate DNA
    b. degrade RNA
    c. to put phosphates on protein substrates
    d. degrade proteins

38. A person that inherits a defective DNA repair system is predisposed to what problem?
    a. Physical deformities
    b. Cancer
    c. Heart disease
    d. Diabetes
    e. None of the above

39. Homologous Recombination
    a. Occurs when 2 DNA helices swap pieces of DNA
    b. Requires homology between the regions of DNA that are swapped
    c. Is the basis of crossing over in meiosis
    d. All of the above are correct
    e. None of the above are correct

40. RNA can fold up into specific, stable shapes, such as stem loops in tRNAs, that are functionally important What type of bonding stabilizes these folded structures?
    a. ionic bonds between two regions of DNA's sugar-phosphate backbone
    b. covalent bonds between the extreme 5' and 3' ends of the RNA
    c. hydrogen bonding between complimentary nucleotides found in different regions of the same RNA
    d. single-stranded binding proteins stabilizes these structures

41. Chromosomes are composed of DNA and _____
    a. lipids
    b. proteins
    c. carbohydrates
    d. steroids
    e. polysaccharides

42. Initiation of translation always begins at a _____ codon with an initiator tRNA bound to _____.
    a. UUA…proline (pro)
    b. AUG…proline (pro)
    c. AUG…methionine (met)
    d. GGG…methionine (met)

43. During translation, the new, incoming tRNA binds to the
    a. P site of the ribosome
    b. A site of the ribosome
    c. E site of the ribosome
    d. Termination codon

44. Termination of translation
    a. occurs at termination codons on mRNA
    b. requires the binding of releasing factors to the A site of the ribosome
    c. results in the dissociation of the ribosome from the mRNA
    d. all of the above are correct
    e. none of the above are correct

45. During protein translation the codon on the _____ base-pairs with the anticodon on the _____, ensuring that the proper amino acid is brought into the ribosome
    a. mRNA…rRNA
    b. mRNA…tRNA
    c. tRNA…mRNA
    d. rRNA…tRNA

46. During the process of transcription
    a. DNA is used as a template for the production of RNA
    b. RNA polymerase catalyzes transcription
    c. Transcription begins at the +1 site adjacent to the promoter
    d. All of the above are correct
    e. Only 2 of the above are correct

47. Which of the following statements best describes Rho-independent termination of transcription?
    a. formation of a stem loop disrupts hydrogen bonding between the DNA template and the RNA causing the RNA to dissociate from the DNA
    b. the sigma factor of RNA polymerase breaks the hydrogen bonds between DNA and RNA causing the RNA to dissociate from the DNA
    c. releasing factor catalyze hydrolysis of the RNA
    d. helicase melts the bonds between the RNA and DNA causing the RNA to dissociate from the DNA

48. The 3 dimensional structure of DNA was discovered by
    a. Homer and Bart Simpson
    b. Beavis and Butthead
    c. Watson and Crick

49. During protein folding, the non-polar, hydrophobic R groups turn in toward the core of the polypeptide because they are repelled by water.
a. true
b. false

50. Enzymes catalyze (speed up) chemical reactions by lowering the energy of activation of the reaction.
a. true
b. false

51. The energy required for the addition of a nucleotide to a growing DNA strand is always provides by the hydrolysis of ATP.

52. Translation of a single polycistronic mRNA yields several different polypeptides.
    a. true
    b. false

53. In the absence of lactose the Lac Operon is repressed, and transcription of the Operon is inhibited by binding of the repressor to the operator.
a. true
b. false

54. A constitutive promoter is always turned off.
a. true
b. false

55. The permease enzyme produced from the Lac Operon functions to transport lactose into E. coli cells across the cell membrane.
a. true
b. false

56. Typically, the flow of genetic information is from DNA to RNA to Protein.
    a. true
    b. false

57. The sequence of amino acids in a polypeptide is dictated by the sequence of nucleotides in the mRNA that encodes that polypeptide.
    a. true
    b. false

58. DNA polymerase cannot synthesize DNA de novo (from scratch). It can only extend an existing nucleotide strand
    a. true
    b. false

59. In prokaryotes, transcription and translation are coupled, therefore ribosomes can begin translation at the 5’ end of an mRNA even before the 3’ end of the mRNA is finished being synthesized.
    a. true
    b. false

60. Ribosomes are composed of both rRNAs and proteins
    a. true
    b. false

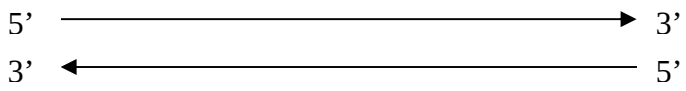
61. Transposase is a transcription factor that inhibits the transcription of transposons.
    a. True
    b. False

Short Answer questions (3 pts each)

1. What are the general characteristics of a Protein Domain?

The protein domain is a region of a protein that can fold independently into a stable structure. Protein domains within a single protein often have different functions.

2. The strands of DNA within the double helix run antiparallel to each other. Draw a simple picture that illustrates the antiparallel nature of double-stranded DNA. Use the symbols 5’ and 3’ to indicate polarity of the molecule



3. How does the Shine-Delgarno sequence help the ribosome to initiate translation at the proper AUG codon?

The Shine Delgarno sequence is a sequence of nucleotides on the mRNA which form specific base pairs with a region of the rRNA within the small ribosomal subunit. This base pairing positions the initiation complex at the appropriate AUG initiation codon on the mRNA.

4. What are the functions of mRNA, tRNA and rRNA?

Messenger RNA (mRNA) contains the sequence of codons that will be translated into a polypeptide by a ribosome.

Transfer RNAs (tRNAs) are adaptors that help the ribosome decode an mRNA. They are charged with an amino acid at one end and have an anticodon at the other end, which functions to base pair with codons on mRNA.

Ribosomal RNAs (rRNA) form most of the structure of a ribosome and catalyze its most important reaction; the formation of peptide bonds between amino acids.

5. What is a transposon and how does it jump from one region of DNA to another?

Transposons are genes that encode a transposae enzyme and that have repeat sequences that flank the boundaries of the gene. Expression of the gene results in the formation of transposase enzymes, which then bind to the repeats and excise (cut) the transposon out of the chromosome. The transposase then facilitates the integration of the transposon into another region of the genome.

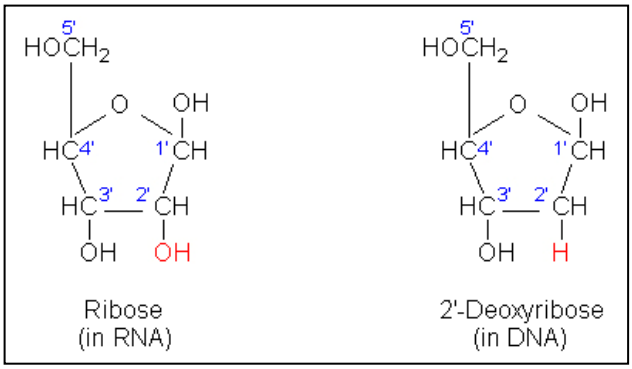
6. What kind of enzyme is the Rho factor and how does it function to terminate transcription in prokaryotes?

Rho is a helicase enzyme capable of breaking hydrogen bonds between nucleotide base pairs. Rho binds to a Rho loading site on the nascent (growing) RNA transcript. Rho slides 5' to 3' along the RNA then breaks the hydrogen bonds between the DNA template and the nascent RNA, resulting in release of the RNA and termination of transcription.

7. How can duplication and divergence result in the evolution of families of related proteins?

Once in a great while a gene might, by mistake, become duplicated in a species. The new copy is not essential, thus it is free to mutate. Certain mutations may provide a novel and useful function for the new protein which increases the fitness of the species. This may happen again and again throughout the evolution of a species, leading to a family of related proteins that have similar, but unique functions.

8. Number the carbons 1'-5' on the ribose and deoxyribose sugar



Essay question (15 points)

Describe the process of DNA replication. Include in your discussion the roles of DNA polymerase, primase, helicase, topoisomerase, single-stranded binding proteins, ligase, Okasaki fragments, and origins of replication. You may include a drawing, but you must describe the process in narrative form. Tell me how this works.

In semiconservative replication, the old strands act as templates for synthesis of new complimentary strands according to specific basepairing, G:C, A:T. Replication begins at an origin of replication. Here the DNA helicase spreads open the double helix by breaking hydrogen bonds, exposing single strands of DNA. Single stranded DNA binding proteins bind to the DNA, preventing the now single strands from reannealing with one another. DNA primase uses the DNA strands as templates to synthesize small, complimentary RNA primers on both parent strands. DNA polymerase extends these primers (from the free 3' OH) in a 5' to 3' direction. The parental strands are antiparallel, thus synthesis of DNA is occurring in two directions at the replication fork. One new strand, called the leading strand, synthesizes DNA toward the fork in a continuous manner. The other strand, called the lagging strand, synthesizes DNA away from the fork in a discontinuous manner, producing small stretches of DNA called Okasaki fragments. As DNA polymerase runs into the RNA primer of an Okasaki fragment, it replaces the RNA with DNA. DNA ligase then seals the gaps between Okasaki fragments. The unwinding of the double helix at the replication fork produces supercoils (twists) in the DNA ahead of the fork. These supercoils are resolved by topoisomerase, an enzyme that cuts the DNA, allows it to swivel, then reseals the DNA.