

Name \_\_\_\_\_

Use complete sentences when requested. There are 100 possible points on this exam. The multiple choice questions are worth 2 points each. All other questions have the points indicated.

- Based on Chargaff's rules, which of the following are possible base compositions for double-stranded DNA?
 

	<u>%A</u>	<u>%G</u>	<u>%C</u>	<u>%T</u>	<u>%U</u>
A)	15	85	85	15	0
B)	20	20	20	20	20
C)	35	15	15	35	0
D)	35	35	15	15	15

E) none of the above or more than one of the above, circle all correct answers
- In the Watson-Crick model of DNA structure (now called B-form DNA):
  - a purine in one strand always hydrogen bonds with a pyrimidine in the other strand.
  - A–T pairs share three hydrogen bonds.
  - G–C pairs share two hydrogen bonds.
  - the 5' ends of both strands are at one end of the helix.
  - the bases occupy the exterior of the helix.

F) None of these or more than one of these, circle all correct answers
- The double helix of DNA in the B-form is stabilized by:
  - covalent bonds between the 3' end of one strand and the 5' end of the other.
  - hydrogen bonding between the phosphate groups of two side-by-side strands.
  - hydrogen bonds between the riboses of each strand.
  - nonspecific base-stacking interaction between two adjacent bases in the same strand.
  - ribose interactions with the planar base pairs.

F) None of these or more than one of these, circle all correct answers
- Triple-helical DNA structures can result from Hoogsteen (non Watson-Crick) interactions. These interactions are primarily:
  - covalent bonds involving deoxyribose.
  - covalent bonds involving the bases.
  - hydrogen bonds involving deoxyribose.
  - hydrogen bonds involving the bases.
  - hydrophobic interactions involving the bases.

F) None of these or more than one of these, circle all of the correct answers
- The ribonucleotide polymer (5')UUGACCAU(3') could only form a double-stranded structure with:
  - (5')ATGGTCAA(3').
  - (5')AACTGGTA(3').
  - (5')AACUGGUA(3').
  - (5')AUCCUGUU(3').

E) None of these or more than one of these, circle all of the correct answers
- The  $t_m$  (melting temperature) for a double-stranded DNA
  - Is lower if there is more GC content
  - Is determined by measuring the absorbance at 280 nm vs temperature
  - Is higher if there is more AT content
  - Is determined by observing the solid DNA becoming a liquid

E) None of these or more than one of these, circle all correct answers

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Total Possible \_\_\_\_\_

7. Restriction enzymes:
- act at the membrane to restrict the passage of certain molecules into the cell.
  - are highly specialized ribonucleases that degrade mRNA soon after its synthesis.
  - are sequence-specific DNA endonucleases.
  - are very specific proteases that cleave peptides at only certain sequences.
  - catalyze the addition of a certain amino acid to a specific tRNA.
8. The biological role of restriction enzymes is to:
- aid recombinant DNA research.
  - degrade foreign DNA that enters a bacterium.
  - make bacteria resistant to antibiotics.
  - restrict the damage to DNA by ultraviolet light.
  - restrict the size of DNA in certain bacteria.
9. The *E. coli* recombinant plasmid pBR322 has been widely utilized in genetic engineering experiments. pBR322 has all of the following features **except**:
- a number of conveniently located recognition sites for restriction enzymes.
  - a number of palindromic sequences near the *EcoRI* site, which permit the plasmid to assume a conformation that protects newly inserted DNA from nuclease degradation.
  - a replication origin, which permits it to replicate autonomously.
  - resistance to two different antibiotics, which permits rapid screening for recombinant plasmids containing foreign DNA.
  - small overall size, which facilitates entry of the plasmid into host cells.
10. (10 points) In order to determine if a mutation has occurred, DNA is sequenced using the Sanger (dideoxy) method. Briefly explain how this method works and then give the sequence of DNA that is represented by the following gel. Be sure to label the 5' and 3' end of the DNA.

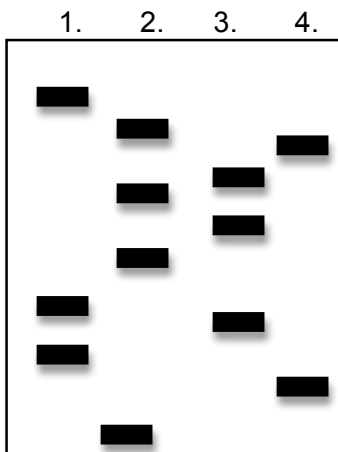


Figure1, DNA sequencing gel for a dodecamer (12 bases) of DNA..

- Lane 1: dATP, dGTP, dCTP, dTTP, ddCTP  
 Lane 2: dATP, dGTP, dCTP, dTTP, ddGTP  
 Lane 3.: dATP, dGTP, dCTP, dTTP, ddTTP  
 Lane 4: dATP, dGTP, dCTP, dTTP, ddATP

11. (9 points) A plasmid that encodes resistance to ampicillin and tetracycline is digested with the restriction enzyme *Bam*HI, which cuts the plasmid at a single site in the tetracycline-resistance gene. The DNA is then annealed with a *Bam*HI digest of human DNA, ligated, and used to transform *E. coli* cells.
- (a) What antibiotic would you put in an agar plate to ensure that the cells of a bacterial colony contain the plasmid?
- (b) What antibiotic-resistance phenotypes will be found on the plate?
- (c) Which phenotype will indicate the presence of plasmids that contain human DNA fragments?
12. (14 points) Matching: match the following Next Gen Sequencing with its chemistry:
- \_\_\_\_\_ a. Nanopore
  - \_\_\_\_\_ b. SMRT
  - \_\_\_\_\_ c. 454 Pyro
  - \_\_\_\_\_ d. Ion semiconductor
  - \_\_\_\_\_ e. heliscope
  - \_\_\_\_\_ f. SOLID
  - \_\_\_\_\_ g. Illumina
- I. A fluorescent molecule on the terminal phosphate is released when base is incorporated into a growing strand
- II. Minute changes in pH are detected each time a base is added.
- III. Pyrophosphate is added to AMP with ATP sulfurylase the product, ATP is used by luciferase to generate light
- IV. Each base has a different fluorescent label. Bridge amplification is used to immobilize the DNA on solid support.
- V. Each base has a different label. DNA is modified with a poly A tail that binds to poly T on a flow cell.
- VI. DNA sample is amplified by emulsion PCR, beads are immobilized on a plate, dinucleotides with fluorescent labels are ligated on to a growing strand.
- VII. A molecule of DNA goes through a very small opening between two electrodes. The potential difference between the electrodes is different for each base.

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Total Possible \_\_\_\_\_

13. (8 points) Cloning is the process of making an exact duplicate. Describe the following four vectors: YAC, BAC, phage and plasmid, that are used to get foreign DNA into a cell for cloning. What are the advantages and disadvantages of each of these?
14. (12 points) What is a DNA microarray? How could a microarray be used to study epigenetics? Use complete sentences.

15. (12 points) Histones are key proteins that can be modified to alter gene expression. Describe how histones are involved in gene expression. How can they be modified? Why is the study of the reactions involved in these modifications related to treating cancer, diabetes and/or HIV? Use complete sentences.
16. (5 points) Draw the structures for dATP and UMP. Circle the atoms that form the hydrogen bonds when Adenine base pairs with Uracil.

17. (12 points) Stem Cells and Cloning topics were presented by students in class. Summarize one of these presentations. Provide specific details from the presentations. It is ok to summarize your own presentation(s). Use complete sentences.