BIOL 102 **Fall 2017** **Exam 1** **75 m.** **30 pt** **170921**

Instructions

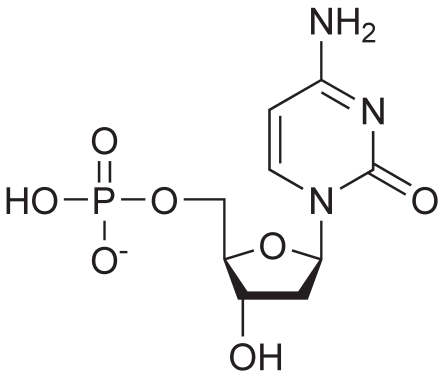
- *Complete this examination within the 75 minutes allotted for the exam*
- *Show as much work as possible for each question*
- *You may not use any electronic device other than one tablet computer while completing this exam*
- *You may not communicate with any other person about this exam during the exam period*
- *You may access digital and written notes, the course textbook, and other internet materials, as long as you do not access audio (even if you have headphones)*

Name: _____ **Student ID number:** _____

1 (2 pt) Purine and pyrimidine nucleotides differ by:

a) the number of aromatic carbon rings in their structures
b) their disribution across isochores
c) the number of hydrogen bonds that they form
d) all of the above

2 (1 pt) On the image of a cytosine nucleotide below, circle the chemical group where DNA polymerase would attach the next nucleotide during DNA replication. Number the carbon atom that chemical group is attached to.



3 (1 pt) Which of the following four DNA strands will form the fewest hydrogen bonds with its complementary strand?

a) AGCTAGCATCAGCTACGACTACGACGAC
b) TCGACTACGATCTATCATCTATCAGCTA
c) GCGCGATCAGCACTACTCGCGATACCGG
d) GCATATCTATCTATATATACTCAAAAAA

4 (2 pt) On the photograph below, draw arrows pointing to all of the telomeres, circle the centromere, label the p and q arms, and very briefly explain what is most likely causing the black and gray bands apparent on the chromosome.

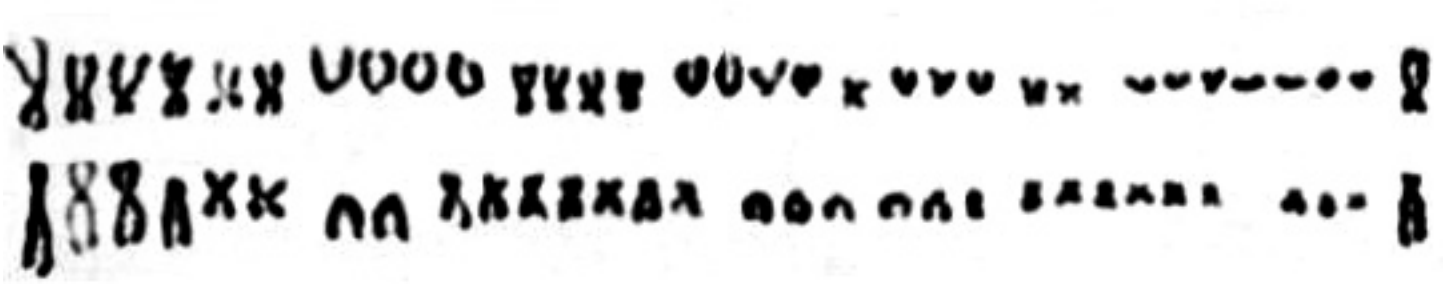
5 (3 pt) On the above image, add the following labels (if applicable): strand, chromosome, chromatid

6 (2 pt) Draw a cartoon representation of the above chromosome that most accurately reflects, after cell division occurs and the daughter cells are in the G1 phase of the cell cycle:
i) what the chromosome will look like, and
ii) where all of the DNA shown above will be located

7 (2 pt) Assuming that the image below is from a diploid organism, provide the following information:

a) Karyotype:

b) Stage of the cell cycle when this image was taken:



8 (1 pt) Look up the DNA sequence associated with NCBI Accession number AC144488.2 and report the first four nucleotides of this sequence:

9 (1 pt) With what frequency will this part of the AC14488.2 sequence likely occur in any random sequence of DNA?

10 (2 pt) Which sequence (a or b) is more likely a restriction endonuclease binding site? Briefly explain.

a) TAAT
b) ATAT

11 (1 pt) The following DNA molecule is exposed to UV light. Circle the nucleotide(s) of the molecule that will most likely be affected.

GCGACTACGACAGCATTGCGACGACACACC

12 (3 pt) On both DNA sequences (i and ii) below, circle (on both sequences) an example of an indel, and draw a double-headed arrow between two nucleotides that constitute a SNP

i 5'-AGCTACTACTACGGCATACTATATATATACGGGACTACTG-3'

ii 5-'AGTTACTACGGCATACTATATACGCGACTACTG-3'

What most likely caused the indel?

Answer only one of the two following questions (either 13a or 13b)

13a (4 pt) Create two 3-nucleotide-long PCR primers that could be used to replicate the entire DNA sequence above (Question 12) from both chromosomes i and ii. Report the sequences, including polarities.

13b (4 pt) Create the most optimal multiple sequence alignment using the four nucleotide sequences provided below, and also write the consensus sequence.

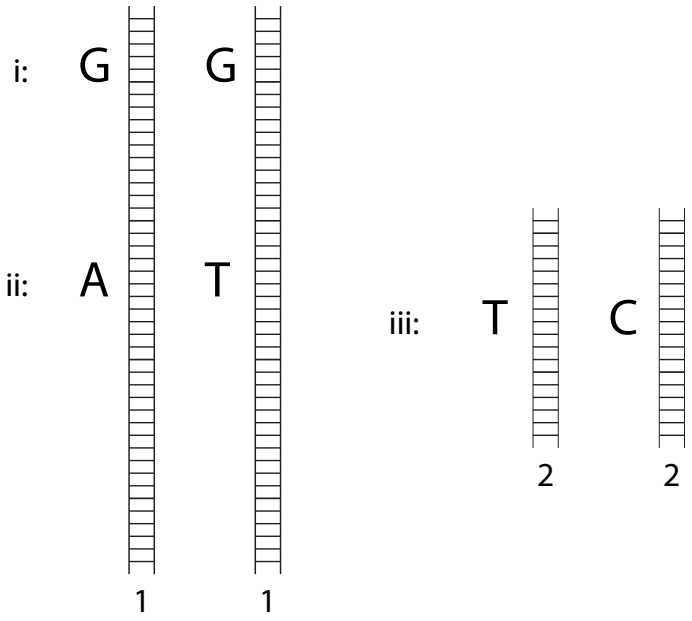
5'-AGCTACGATC-3'
5'-CTACAATCGC-3'
3'-CATCGTTCGC-5'
5'-TACGATCGCA-3'

14 (3 pt) The cartoon below shows a normal (diploid, G1) nucleus containing two pairs of chromosomes (1 and 2, numbered below). I have provided the nucleotides present at three loci (i, ii, and iii) on these chromosomes.

a) using appropriate notation, write the genotype of this individual on chromosome 2

b) using appropriate notation, write a chromosome 1 haplotype

c) circle a heterozygous locus



15 (2 pt) Below are the STR allele frequency tables for two US populations. In which population (African American or Caucasian) is the combination of D5S818 allele 8 and TPOX allele 12 more common? Show your work.

TABLE 2—*U.S. African American allele frequencies for 15 autosomal STR loci (N = 258)*

Allele	CSF1PO	FGA	TH01	TPOX	VWA	D3S1358	D5S818	D7S820	D8S1179	D13S317	D16S539	D18S51
5	--	--	0.004	--	--	--	--	--	--	--	--	--
6	--	--	0.124	0.101	--	--	--	0.002	--	--	--	--
7	0.053	--	0.421	0.017	--	--	--	0.016	--	--	--	--
8	0.060	--	0.194	0.372	--	--	0.048	0.236	0.002	0.033	0.039	--
8.1	--	--	--	--	--	--	--	--	--	--	--	--
9	0.037	--	0.151	0.178	--	--	0.039	0.109	0.006	0.033	0.196	0.004
9.3	--	--	0.105	--	--	--		0.002	--	--	--	--
10	0.257	--	0.002	0.089	--	--	0.070	0.331	0.029	0.023	0.116	0.006
10.3	--	--	--	--	--	--	--	--	--	--	--	--
11	0.249	--	--	0.219	--	--	0.233	0.203	0.045	0.306	0.318	0.002
12	0.298	--	--	0.021	0.002	--	0.353	0.087	0.141	0.424	0.196	0.078

TABLE 1—*U.S. Caucasian allele frequencies for 15 autosomal STR loci (N =302).*

Allele	CSF1PO	FGA	TH01	TPOX	VWA	D3S1358	D5S818	D7S820	D8S1179	D13S317	D16S539	D18S51
5	--	--	0.002	0.002	--	--	--	--	--	--	--	--
6	--	--	0.232	0.002	--	--	--	--	--	--	--	--
7	--	--	0.190	--	--	--	0.002	0.018	--	--	--	--
8	0.005	--	0.084	0.535	--	--	0.003	0.151	0.012	0.113	0.018	--
8.1	--	--	--	--	--	--	--	0.002	--	--	--	--
9	0.012	--	0.114	0.119	--	--	0.050	0.177	0.003	0.075	0.113	--
9.3	--	--	0.368	--	--	--	--	--	--	--	--	--
10	0.217	--	0.008	0.056	--	--	0.051	0.243	0.101	0.051	0.056	0.008
10.3	--	--	--	--	--	--	--	--	--	--	--	--
11	0.301	--	0.002	0.243	--	0.002	0.361	0.207	0.083	0.339	0.321	0.017
12	0.361	--	--	0.041	--	--	0.384	0.166	0.185	0.248	0.326	0.127