PLSC 111, Exam I, Name
Genetics and You Date

1. In dogs, dark coat color is dominant over albino, and short hair is dominant over long hair. If two independently assorting genes cause these effects, write the genotypes of the parents in each of the crosses shown in the following table. Use the symbols C and c for the dark and albino coat color alleles, and S and s for the short hair and long hair alleles, respectively. Assume homozygosity unless there is evidence otherwise.

	Parental phenotypes	Number of progeny			
		Dark, short	Dark, long	Albino, short	Albino, long
1	Dark, short x dark, short	89	31	29	11
2	Dark short x dark, long	18	19	0	0
3	Dark short x albino, short	20	0	21	0
4	Dark short x dark, long	30	31	9	11
5	Albino long x dark short	20	19	22	18

	Genotype of parents
1	
2	
3	
4	
5	

2. In humans, the disease galactosemia is inherited as a single gene recessive trait in a simple Mendelian manner. A woman whose father had galactosemia intends to marry a man whose grandfather was galactosemic. They are worried about having a galactosemic child. What is the probability of this outcome?
3. In the Amazon jungles of Brazil, a small tribe was discovered. A study of four mating that occurred in the group in the course of several years produced the results shown in the following table.

Mating	Parent #1	Parent #2	Progeny
1	Six toes, hairy knees	Six toes, hairy knees	¾ six toes, hairy knees ¼ five toes, hairy knees
2	Six toes, smooth legs	Five toes, smooth legs	½ six toes, smooth legs ½ five toes, smooth legs
3	Six toes, hairy knees	Five toes, smooth legs	¼ six toes, smooth legs ¼ six toes, hairy knees ¼ five toes, hairy knees ¼ five toes, smooth legs
4	Six toes, hairy knees	Six toes, hairy knees	¾ six toes, hairy knees ¼ six toes, smooth legs

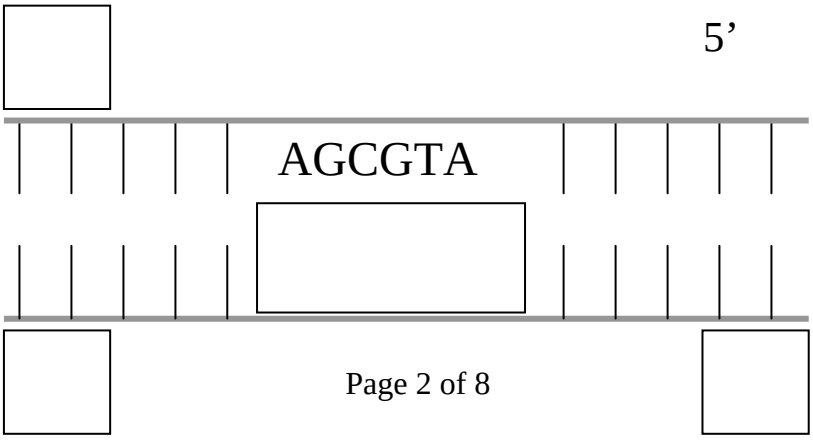
   a. How many genes are involved in these phenotypes?
   b. Which character differences are controlled by which alleles of these genes?

c. Which alleles are dominant or recessive?
d. There were in fact only five parents participating in these mating. Give the genotypes of these five individuals.

4. Following refers to chromosome theory of inheritance:
   a. A cell with 10 pairs of chromosomes undergoes mitosis, how many chromosomes does each of the resulting cells have?
   b. A cell with 10 pairs of chromosomes undergoes meiosis, how many chromosomes does each of the resulting cells have?
   c. Chromosomes pair during which event, mitosis or meiosis?
   d. Chromosome pairing results in what process?
   e. Which one of Mendel's laws had to be modified due to the above event (name the law)?
5. In human beings, the absence of molars is inherited as a dominant trait. If two heterozygotes have four children, what is the probability that:
   a. All will have no molars?
   b. Three will have no molars and one will have molars?
   c. The first two will have molars and the second two will have no molars?
6. The father of Mr. Spock, second officer of the Starship Enterprise, came from the planet Vulcan; his mother came from Earth. A Vulcanian has pointed ears (E), adrenals absent (A), and right-sided heart (R). All of these genes are autosomal (i.e. not sex linked) and Vulcanian alleles are dominant over Earth alleles. Since Mr. Spock lived a long time he sired many children. Following is data collected from his children as well as those from his ten other siblings (sorry they forgot to mention this on Star Trek):

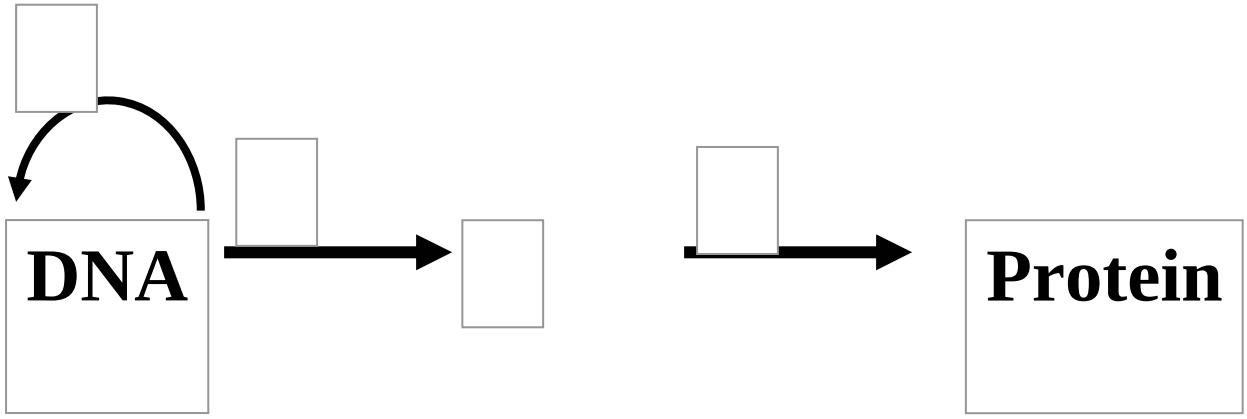
Phenotype			Number of children
E	A	R	50
e	a	r	33
E	A	r	3
e	a	R	4
e	A	R	6
E	a	r	4
Total			100

   a. Calculate the recombination distance between R and A?
   b. Calculate the recombination distance between R and E?
   c. Calculate the recombination distance between E and A?
   d. Draw a linkage map of these three loci.
7. Given the following figures fill in the blank boxes:



a. What is the complementary RNA sequence derived from AGCGTA?

8. Given the following figures fill in the blank boxes:



9. What are the three major elements of any DNA/genes (i.e. gene design) used to transform a plant? Please provide an example for each.
10. In the "National Geographic" articles discussed in the class various methods by which genetic testing is being employed was mentioned. Name five different examples for which this method is being used, and give a short one-sentence description.

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1. Consider the following crosses in *Drosophila*. Based on the results, deduce which alleles are dominant and the genotypes of the parents. Orange and red are eye colors; crossveins occur on the wings.

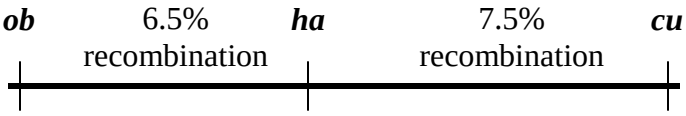
	Parents	Progeny			
		Orange, crossvein	Orange, crossveinless	Red, crossveins	Red, crossveinless
1	Orange, crossveins X orange, crossveins	83	26	0	0
2	Red crossveins X red, crossveinless	20	18	65	63
3	Red crossveinless X red, crossveins	0	0	74	81
4	Red crossveins X red, crossveins	28	11	93	34

a. Number of genes, their alleles and dominance relationship

b.

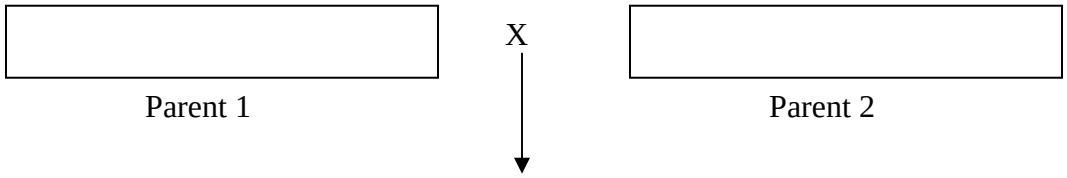
	Genotype of parents
1	
2	
3	
4	

2. In humans, enlarged cornea is inherited as a single gene recessive trait located on the X chromosome. A woman whose father had enlarged cornea intends to marry a man whose grandfather had enlarged cornea. They are worried about having children with this disease.
   a. What is the probability of their daughter having this disease?
   b. What is the probability of their son having this disease?
3. In lab mice, obese (*ob*), happy (*ha*), and cuddly (*cu*) are linked on chromosome 1 with the following arrangement:



Devise a data set of 100 individuals that would yield the above values

a.



b.

Phenotype	Number of children
Total	100

4. Fill in the following blank spaces:
   e. The process by which DNA copies itself is called_____
   f. The process by which DNA is copies into RNA is called_____
   g. The process by which RNA is copied into protein is called_____
   h. Proteins are made from _____

i. _____ nucleotide combinations represent a code used for converting RNA into protein

4. The arctic fox has fifty small chromosomes.
   f. If this fox gets wounded, by what cellular division process does it heal itself?
   g. How many chromosomes would these new cells have?
   h. When it mates with another fox by what cellular division process does it produce gametes?
   i. How many gametes does it produce from each single primary cell?
   j. How many chromosomes would each gamete have?

6. What are the three major differences between DNA and RNA?

7. What are three of the major tools used in recombinant DNA?

8. Assume that Mendel looked simultaneously at four traits of his pea plants (each trait exhibited dominance). If he crossed homozygous dominant plant with a homozygous recessive plant, all the F1 offspring would have been of the dominant phenotype. If he then selfed the F1 plants:
   a. How many different types of gametes would these plants have produced?
   b. How many different genotypes would have appeared in the F2 generation?
   c. What proportion of the F2 offspring would have been of the homozygous recessive phenotype for all four genes?

9. In the "National Geographic" articles discussed in the class various methods by which genetic testing is being employed was mentioned. Name five different examples for which this method is being used, and give a short description.

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1. In mice, long tail is dominant over short tail, and black hair color is dominant over brown. Two independently assorting genes cause these effects; write the genotypes of the parents in each of the crosses shown in the following table. Use the symbols L and l for the long and short tail alleles, and B and b for the black and brown hair color alleles, respectively. Assume homozygosity unless there is evidence otherwise.

	Parental phenotypes	Number of progeny			
		Long, black	Long, brown	Short, black	Short, brown
1	Long, black x long, brown	30	32	0	0
2	Long, black x long, black	43	17	15	6
3	Short, black x long, brown	25	0	28	0
4	Short, black x long, black	0	0	43	12
5	Long, black x short, brown	17	13	14	16

	Genotype of parents
1	
2	
3	
4	
5	

2. In a laboratory experiment with flies, a white-eyed female fly was crossed to a red-eyed male. All female progeny (i.e. F_1 generation) had red eyes and all male progeny had white eyes. The F_1 progenies were inter-mated to each other (i.e. red-eye female x white-eye male). The results form this was a 1:1 ratio of red-eyed to white-eyed flies (same ratio in both male and female). Diagram and explain the results (the dominance vs. recessive alleles and ratios) in terms of sex chromosome linkage.
3. In cats the genes for cuddly (*cu*), happy (*ha*) and playful (*pl*) are linked on chromosome 3 and are recessive to un-cuddly, angry, and lazy. Progeny in the following table were recovered from the testcross of the F1 progeny from homozygous recessive to homozygous dominant.

cu cu ha ha pl pl x + + + + + +

↓

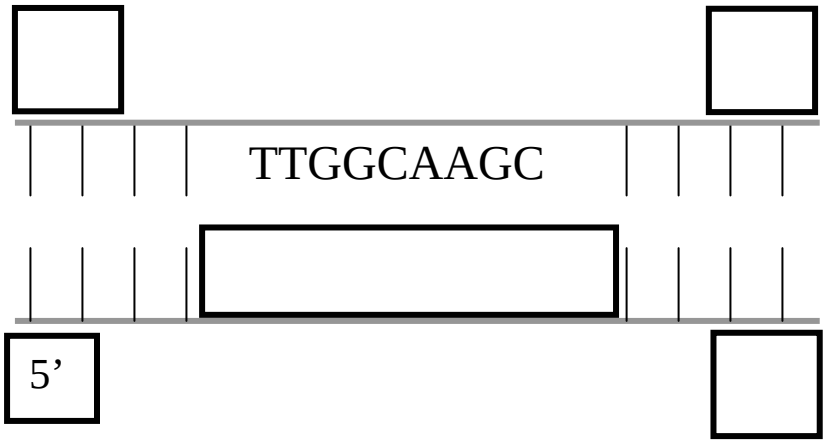
F_1 x *cu cu ha ha pl pl*

↓

Phenotype			Number of children
+	+	+	39
cu	*ha*	*Pl*	46
cu	+	*pl*	6
+	*ha*	+	4
+	*ha*	*pl*	3
cu	+	+	2
Total			100

   e. Calculate the recombination distance between *cu* and *ha*?
   f. Calculate the recombination distance between *cu* and *pl*?
   g. Calculate the recombination distance between *pl* and *ha*?
   h. Draw a linkage map of these three loci.
4. What are the three classes of molecules used to construct DNA (components of the double helix)?

5. How many different bases are present in a DNA molecule? What are their designations? Which ones pair with each other?
6. What are the three required properties of genetic material (i.e. DNA)?
7. How many different codons are there in the genetic code? Do plants, humans and fungus use the same genetic code? What is the difference or similarity?
8. What radio-isotopes (i.e. radioactive elements) were used in the Hershey and Chase (bacteria and virus) experiments to prove that DNA was the genetic material? Why were they chosen?
9. In the "National Geographic" articles discussed in the class various ways by which genetic testing is being employed was mentioned. Name six different examples for which this method is being used, and give a short description of each.
10. Assume that Mendel looked simultaneously at six traits of his pea plant (each trait exhibited dominance). If he crossed homozygous dominant plant with a homozygous recessive plant, all the F_1 progeny would have been of dominant phenotype. If he then selfed these F_1 plants:
    i. What would be the genotype of F_1 plants?
    ii. How many different types of gametes would these plants have produced?
    iii. How many different genotypes would have appeared in the F_2 generation?
    iv. What proportion of the F_2 offspring would have been of the homozygous recessive phenotype for all six genes?
11. Given the following figures fill in the blank boxes:



a. What is the complementary RNA sequence derived from TTGGCAAGC?

12. Bread wheat growing in North Dakota farms has 21 pairs (total of 42) chromosomes.
    a. How many chromosomes would the bread wheat coming from Australia have?
    b. How many chromosomes would you expect to see in the leaf cells of North Dakota grown bread wheat plant?
    c. By what cellular division process are new leaves on the bread wheat plant produced?
    d. Bread wheat flower has both the male and female sex organs (i.e. the same as pea flowers). How many chromosomes would the gametes (pollen and egg) produced in those flowers have?
    e. What cellular division produces these gametes?

f. Where do you expect to see chromosomes paired with each other, in the leaf or in the flower?
g. Why do chromosomes pair?