Problem Set 3

Name:_____

1. Explain how gel electrophoresis can be used to determine the size of a PCR product.

2. (*17.17 of 3rd ed., *19.19 of 2nd ed.) In the presence of high intracellular concentrations of tryptophan, only short transcripts of the trp operon are synthesized because of attenuation of transcription at a point 5' to the structural genes. This is mediated by the recognition of two Trp codons in the leader sequence. If these codons were mutated to UAG stop codons, what effect would this have on the regulation of the operon in the presence and absence of tryptophan? Explain.

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3. The *lac* operon of *E. coli* controls the expression of genes that code for enzymes involved in lactose metabolism. The operon system is inducible in that it can be 'turned on' by the presence of lactose. Mutations to various regions of the *lac* operon have been discovered which affect both the control of gene expression and the function of the gene products. These mutations include:

I^- = produces a repressor protein that can not bind to the operator region

I^S = produces a repressor protein that can not be removed from the operator region

O^C = can not bind a repressor protein

Z^- = produces a defective (non-functioning) β-galactosidase enzyme

Referring to the diagram of the *lac* operon in your text, detail the functionality of the *lac* operon under the following genetic and cellular conditions.

GENES	Lactose present	Repressed (yes/no)	Constitutive (yes/no)	Inducible (yes/no)
$I^+O^+Z^+$	no			
$I^+O^CZ^+$	no			
$I^SO^+Z^+$	yes			
$I^-O^+Z^+$	yes			
$I^SO^CZ^+$	no			

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4. Generate the gametes that can be produced by individuals with the genotypes listed below.

a. Tt

b. Tt,PP

c. Tt, Rr

d. Tt, Pp, rr, Jj

5. How many gamete types can each individual below produce?

a. AA

b. Aa, BB

c. Aa, Bb, CC

d. aa, BB, cc

e. Aa, Bb, Cc

f. Aa, Bb, Cc, Dd

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6. Using Punnett squares and the dominance relationships of various trait values in Mendel's peas, determine the expected genotypic and phenotypic ratios from the following crosses.

Allele Key:

T = tall plant, dominant	t = dwarf plant, recessive
R = round seed, dominant	r = wrinkled seed, recessive
G = green pod, dominant	g = yellow pod, recessive

a. Tt X Tt

b. Rr, Gg X Rr, gg

7. Use the forked-line method to determine the expected phenotypic ratio of the offspring from the following cross.

a. Tt, gg X Tt, Gg

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8. Use χ^2 to determine whether these F2 results follow Mendelian predictions. All parents are from true-breeding lines.

a. **Parental Cross:** Tall plant, round seed X dwarf plant, wrinkled seed

	F2 Offspring
284	Tall plant, round seed
86	Tall plant, wrinkled seed
102	Dwarf plant, round seed
34	Dwarf plant, wrinkled seed

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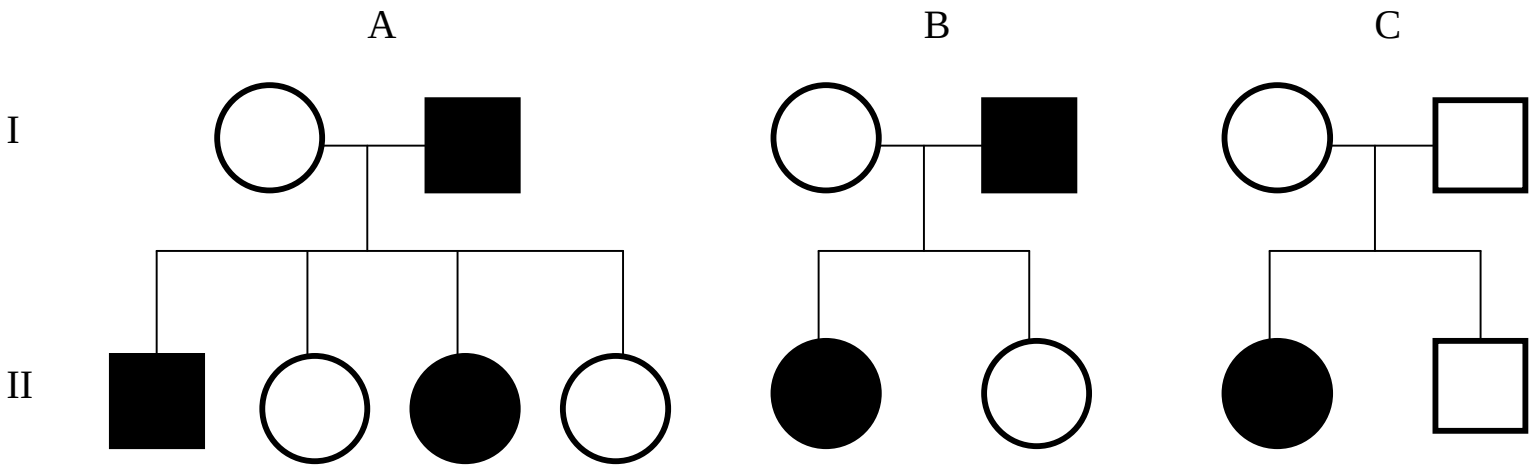
9. (*12.37 of 2nd ed., *12.42 of 3rd ed.) In human genetics, the pedigree is used for analysis of inhertance patterns. Females are represented by circles and males by squares. The following figure presents three 2-generation family pedigrees for a trait in humans. Unaffected individuals are represented by unshaded symbols and affected individuals by shaded symbols. For each pedigree (A, B, and C), state (yes or no) whether transmission of the trait can be accounted for on the basis of each of the listed simple modes of inheritance.



	Pedigree A	Pedigree B	Pedigree C
Autosomal recessive	_____	_____	_____
Autosomal dominant	_____	_____	_____
X-linked recessive	_____	_____	_____
X-linked dominant	_____	_____	_____

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10. For the given pedigree, determine what the possible modes of inheritance may be. Be sure to include uniparental inheritance and maternal effects in your analysis.

Autosomal Recessive:

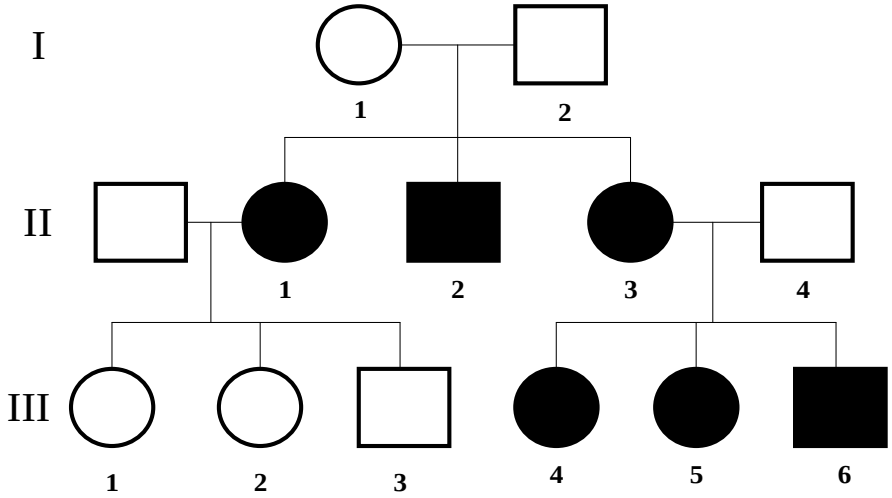
Autosomal Dominant:

X-linked Recessive:

X-linked Dominant:

Y-linked:

Uniparental Inheritance:



Maternal Effect:

11. (*13.26 of 2nd ed., *13.10 of 3rd ed.) In four-o'clock plants, two genes, Y and R, affect flower color. Neither is completely dominant, and the two interact with each other to produce seven different flower colors:

Y/Y R/R = crimson
Y/y R/R = magenta
Y/Y R/r = orange-red
Y/y R/r = magenta-rose
Y/Y r/r = yellow
Y/y r/r = pale yellow
y/y R/R, *y/y R/r*, and *y/y r/r* = white

a. In a cross of a crimson-flowered plant with a white one (y/y r/r) what will the appearances F_1 plants, the F_2 plants, and the offspring of the F_1 plants backcrossed to their crimson parents be?

b. What will the flower colors in the offspring of a cross of orange-red X pale yellow be?

c. What will the flower colors in the offspring of a cross of a yellow with a y/y R/r white be?

12. (13.32 of 2nd ed., 13.14 of 3rd ed.) In *Drosophila*, a mutant strain has plum-colored eyes. A cross between a plum-eyed male and a plum-eyed female gives ⅔ plum-eyed and ⅓ red-eyed (wild type) progeny flies. A second mutant strain of *Drosophila*, called stubble, has short bristles instead of the normal long bristles. A cross between a stubble female and a stubble male gives ⅔ stubble and ⅓ normal-bristled flies in the offspring. Assuming that the plum gene assorts independently from the stubble gene, what will be the phenotypes and their relative proportions in the progeny of a cross between two plum-eyed, stubble-bristled flies? (Both genes are autosomal).