Name: Key 2021 Date: __/__/__ Period: ____

AP Biology Mendelian Genetics' Packet: Mendelian Genetics: Genotypes

1. For each of these genes, give the **genotype** that would be homozygous dominant (HD), heterozygous (He), and homozygous recessive (hr).

Y → HD: YY He: Yy hr: yy Q → HD: QQ He: Qq hr: qq E → HD: EE He: Ee hr: ee

M → HD: MM He: Mm hr: mm F → HD: FF He: Ff hr: ff G → HD: GG He: Gg hr: gg

2. For each of the **genotypes** below determine what **phenotypes** would be possible.

a. Purple flowers are dominant to white flowers.

PP purple

Pp purple

pp White

b. Curly Hair in cats is recessive to straight hair.

BB Straight hair

Bb Straight hair

bb Curly hair

Mendelian Genetics: Independent Assortment Probability

3. Read each scenario carefully and give an answer in percent:
   a. What is the chance a heterozygous parent passes on a recessive allele? 50%
   b. What is the chance a homozygous recessive parent passes on a dominant allele? 0%
   c. What is the chance a homozygous dominant parent passes on a dominant allele? 100%

Monohybrid Cross Problems

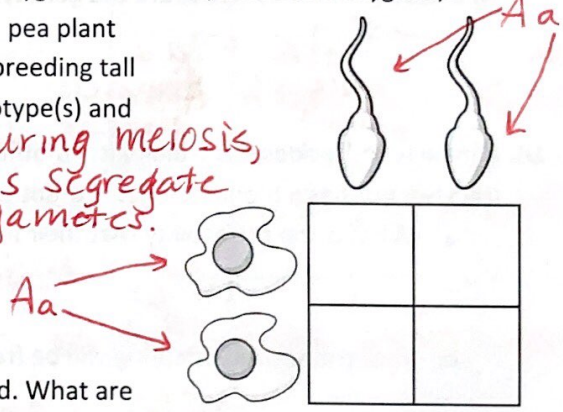
For the following problems, SHOW ALL OF YOUR WORK. For each cross, be sure to give the genotype(s) of the biological parents and the resulting genotype(s) and phenotype(s) of the offspring. For consistency, all probabilities should be expressed as percentages (e.g. 50% homozygous dominant, 50% heterozygous).

4. The gene for tall (A) is dominant over dwarf (a) in the garden pea plant used by Mendel. A pea plant that comes from a line of true-breeding tall plants is crossed with a dwarf pea plant. What are the phenotype(s) and genotype(s) of the F1 generation?

P_1 AA × aa

F_1 Aa

During meiosis, alleles segregate into gametes.



5. Two plants from the F1 generation of question #4 are crossed. What are the genotype(s) and phenotype(s) ratios of the offspring?

Aa × Aa

	A	a
A	AA	Aa
a	Aa	aa

75% tall
25% short

F f

6. The gene for flower color for pea plants codes for two types of flower color, purple and white flowers. You do a test cross between a purple and white flower. All out of the 18 flowers in the next generation are purple. What is the genotype of the purple and white flower in the P generation? What are the genotypes of the purple flowers in the F1 generation?

↳ most likely - (but you don't know for absolute certainty)

FF x ff

F1: Ff

7. In humans, freckles are a trait that exhibits simple dominance. The two alleles for this trait are freckles (A) and no freckles (a). A freckled male whose biological mother has no freckles has a child with a female with no freckles. What is the probability that their first child will have freckles? Use the Punnett square to the right to show your work.

Aa x aa

	a	a
A	Aa	Aa
a	aa	aa

50% freckles
50% No freckles

8. The genes for freckles is dominant over genes for no freckles. A male with freckles has a child with a female without freckles. They have 12 children who all have freckles. What are the most likely genotypes of the biological parents, and all the offspring?

most likely: AA (male parent) x aa (female parent)

Aa = offspring

9. A freckled male has a child with a female without freckles. They have four offspring, two with freckles, and two without freckles. What are the genotypes of all these people?

aa ← Aa (male parent) x aa (female parent) → Aa

offspring: Aa & aa

10. A male with freckles has a biological mother without freckles. The male has a child with a female who has freckles, but has a biological male parent without freckles.

a. What is the probability that their first offspring having freckles?

Aa x Aa

	A	a
A	AA	Aa
a	Aa	aa

75%

b. That the second offspring will be freckles?

75% (each is an independent event)

11. A male and a female have 24 biological children!!! Of the offspring, 17 have freckles and 7 don't have freckles. What are the genotypes of the biological parents?

most likely: Aa x Aa but could be

Aa x aa

Mendelian Genetics: Independent Assortment Problems

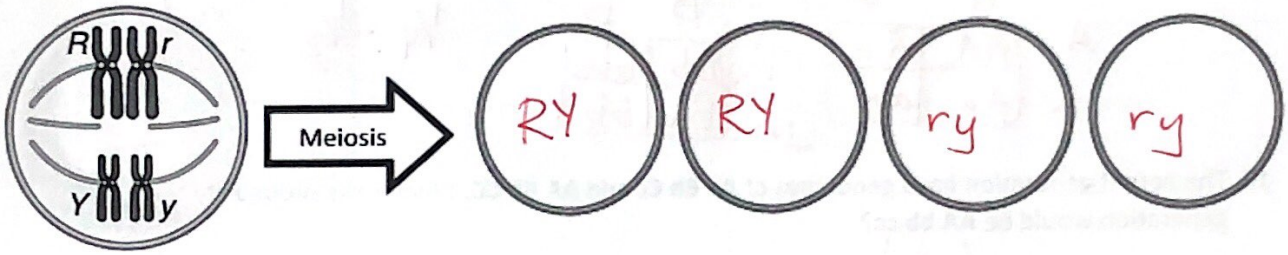
12. One gene has alleles A and a. Another has alleles B and b. For each genotype listed, what type(s) of gametes will be produced? (Assume independent assortment occurs before gametes form.)

- AABB AB
- AaBB AB, aB
- Aabb Ab, ab
- AaBb AB, Ab, aB, ab

13. Assume that you now study a third gene having alleles C and c. For each genotype, what type(s) of gametes will be produced?

- AABBCC ABC
- AaBBcc ABc, aBc
- AaBbCc ABC, AbC, Abc, aBC, abC, abc

14. The cell below is currently in Metaphase I. Draw the four resulting cells after the original cell goes through Meiosis. Write down the genotype above each of the new cells. (ignore crossing over)



Mendelian Genetics: Dihybrid Cross

Set up a dihybrid Punnett square using the following information:

- Dominant allele for green peas in pea plants = A
- Recessive allele for yellow peas in pea plants = a
- Dominant allele for smooth surface in pea plants = B
- Recessive allele for wrinkled surface in pea plants = b

Cross a heterozygous parent (AaBb) with a heterozygous parent (AaBb). Answer the following questions about the ratios from the dihybrid Punnett square. = AaBb x AaBb

	AB	Ab	aB	ab
AB	AABB	AABb	AaBB	AaBb
Ab	AABb	AAbb	AaBb	Aabb
aB	AaBB	AaBb	aaBB	aaBb
ab	AaBb	Aabb	aaBb	aabb

15. What are ALL of the genotypes for each of the following types of pea plants?

a. Green and Smooth: AABB, AABb, AaBB, AaBb
b. Yellow and Smooth: aaBB, aaBb
c. Green and Wrinkled: AAbb, Aabb
d. Yellow and Wrinkled: aabb

16. What is the ratio and probability for each phenotype below?

a. Green and Smooth - Ratio: 9 Probability: 9/16
b. Yellow and Smooth - Ratio: 3 Probability: 3/16
c. Green and Wrinkled - Ratio: 3 Probability: 3/16
d. Yellow and Wrinkled - Ratio: 1 Probability: 1/16

Mendelian Genetics: Product and Sum Rules (Read Section 14.2 in text book)

Directions: For each of the following problems, calculate the probability of the offspring between the cross using the sum and product rule. For these problems, try not creating a di or trihybrid Punnett squares.

17. The parent generation have genotypes of **Aa** and **Aa.** What is the probability the F1 generation would be **Aa**?

	A	a
A	AA	Aa
a	Aa	aa

50%

18. The parent generation have genotypes of **Aa Bb** and **Aa bb.** What is the probability the F1 generation would be **aa Bb?**

	A	a
A	AA	Aa
a	Aa	aa

	B	b
b	Bb	bb
b	Bb	bb

$1/4 \cdot 1/2 = 1/8$

19. The parent generation have genotypes of **Aa Bb Cc** and **AA Bb CC.** What is the probability the F1 generation would be **AA bb cc**?

$1/2 \cdot 1/4 \cdot 0 = 0$

20. The parent generation have genotypes of **AA Bb CC Dd** and **Aa bb Cc dd.** What is the probability the F1 generation would be **Aa bb Cc dd** or **AA bb Cc dd**?

$1/2 \cdot 1/2 \cdot 1/2 \cdot 1/2 = 1/16$ $\quad$ $1/2 \cdot 1/2 \cdot 1/2 \cdot 1/2 = 1/16$

21. The parent generation have genotypes of **Aa Bb cc DD** and **Aa Bb cc dd.** What is the probability the F1 generation would be **Aa bb cc Dd**?

$1/2 \cdot 1/4 \cdot 1 \cdot 1 = 1/8$

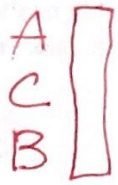
22. The parent generation have genotypes of **Aa Bb Cc dd Ee** and **Aa bb Cc Dd ee.** What is the probability the F1 generation would be **aa Bb Cc Dd Ee**?

$1/4 \cdot 1/2 \cdot 1/2 \cdot 1/2 \cdot 1/2 = 1/64$

Genetic Recombination Problems

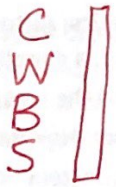
23. Determine the sequence of genes A, B, and C on a chromosome. Which two genes are most likely going to be inherited together?

Genes	Crossover Frequency
A & B	24%
A & C	11%
B & C	13%



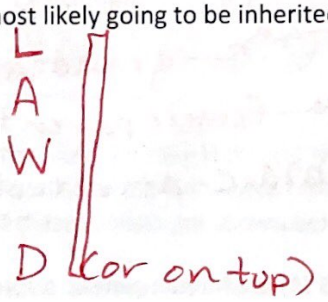
24. The following chart shows the crossover frequencies for some genes on an autosome of organism Y. Construct a chromosome map. Which two genes are most likely going to be inherited together?

Genes	Crossover Frequency
W & S	8%
C & W	3%
C & B	5.5%
C & S	11%
B & S	5.5%



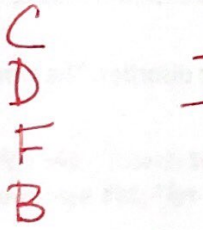
25. The following chart shows the crossover frequencies for some genes on an autosome of organism Z. Construct a chromosome map. Which two genes are most likely going to be inherited together?

Genes	Crossover Frequency
A & W	15%
W & L	35%
A & L	15%
A & D	20%



26. Thomas Morgan collected the following crossover gene frequencies while studying *Drosophila*. Bar-shaped eyes are indicated by the (B) allele, and carnation eyes are indicated by the allele (C). Fused veins on wings (F), leg length (C), and scalloped wings (D) are located on the same chromosomes. Construct a chromosome map. Which two genes are most likely going to be inherited together?

Genes	Crossover Frequency
A & B	24.0%
A & C	8.0%
C & D	2.0%
A & F	16.0%
F & B	8.0%
D & F	6.0%



↳ The closer they are on the chromosome, the more likely they will be inherited together

27. Construct a gene map given the following information. Which two genes are most likely going to be inherited together?

Genes	Crossover Frequency
A & C	8%
A & D	10%
B & D	14%
B & F	8%
C & D	2%
C & F	8%
D & F	6%

A
C
D
F
B

Mendelian Genetics: Autosomal Dominant and Recessive Genetics

28. A young male recently learned from a genetics doctor that they had a condition called Friedreich's ataxia. This syndrome affects the arms and the legs with the person usually needing a wheelchair. Neither of their biological parents have this disorder. However the young male's biological grandfather was wheelchair bound, but didn't know why because genetic information was very limited when the grandfather grew up. Based on this information, what type of inheritance does Friedreich's ataxia follow? Explain why. What are the genotypes of each of the individuals mentioned in this question?

recessive blc it skips a generation
A- ⊤ aa ← grandfather
A- ⊤ Aa ← female parent
aa = male affected

29. Sickle cell anemia (SCA) is a human genetic disorder known to be caused by a recessive allele. A couple plans to marry and wants to know the probability that they will have an affected child. In the following scenarios, use your knowledge of Mendelian inheritance to give the families the probabilities of having a child with SCA.

a. The man and woman do not have SCA. However, each has one parent with the disorder.

Aa & Aa.

b. The man is affected by the disorder. The woman has no family history of SCA.

aa

A_
↑ probably A but unknown

30. A 38-year-old male (Hh) recently has been diagnosed with familial hypercholesterolemia which is a dominant autosomal disorder. Prior to his diagnosis, he and his spouse had 3 children, a male first and then two females. The spouse was recently tested negative for familial hypercholesterolemia (hh). One of the females tested positive for the disease while the other two siblings tested negative. What are the genotypes of the children? What is the probability the next child inherits the disease?

↳ Hh
hh
hh

Hh x hh

	h	h
H	Hh	Hh
h	hh	hh

50% Chance

Mendelian Genetics: Two factor Crosses

31. In guinea pigs, dark fur is dominant to light fur and rough coat texture is dominant to smooth coat texture. What are the predicted genotype and phenotype ratios of a cross between a guinea pig that is heterozygous for both traits with another light-furred guinea pig who is heterozygous for texture?

FfRr x ffRr

3/8 dark + rough
3/8 light + rough
1/8 dark + smooth
1/8 light + smooth

	FR	Fr	fR	fr
FR	FfRR	FfRr	ffRR	ffRr
fr	FfRr	Ffrr	ffRr	ffrr

F f G

32. In watermelon, the allele for short fruit is dominant to the allele for long fruit, and the allele for green fruit is dominant to the allele for mottled fruit. Each of four short, green plants were crossed with a different long, mottled plant. The phenotypes of the offspring of these crosses are shown below:

*Note: This is considered a **test cross**. The genotypes of phenotypically dominant individuals can be determined through crossing them with homozygous recessive individuals.*

Plant	Short, green	Short, mottled	Long, green	Long, mottled
1	28	30	33	31
2	71	0	60	0
3	109	0	0	0
4	49	56	0	0

g

FfGg x ffgg
FfGG x ffgg
FFGG x ffgg
FFGg x ffgg

What are the genotypes of plants 1-4?

***HW: Review chapter 14 in the textbook for class on Monday, March 1st. Come to class with questions on topics on which you require more clarification.** Review Page 290: Tips for Genetics Problems!**