Name: _____

INHERITANCE

Topic 2: Non-Mendelian Inheritance

Other Modes of Inheritance

Not all traits are inherited as a result of an autosomal dominant or autosomal recessive allele. Other modes of inheritance break the rules of Mendelian inheritance. Summarize each in the table below...

Mode of Inheritance	Definition	Examples
Incomplete Dominance		
Co-dominance		
Sex-linked traits		
Multiple Alleles		

Mode of Inheritance	Definition	Examples
Polygenic Traits		
Pleiotropic Traits		
Barr Bodies		
Epigenetics		
Linked Genes		

Practice

INCOMPLETE DOMINANCE

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1) In some varieties of flowering plants, petal colour is determined by two alleles which demonstrate incomplete dominance. One version of the allele, R_1 , encodes red flowers, while another version of the allele, R_2 , encodes white flowers.

   a. Determine the genotype of each of the following plants:

Red flowers	White flowers	Pink flowers

   b. A plant with red flowers is crossed with a plant with pink flowers. What proportion of offspring will also have pink flowers? *(use a Punnett Square to support your answer)*

   c. Is it possible for the cross described in part b to produce offspring with white flowers? Explain.

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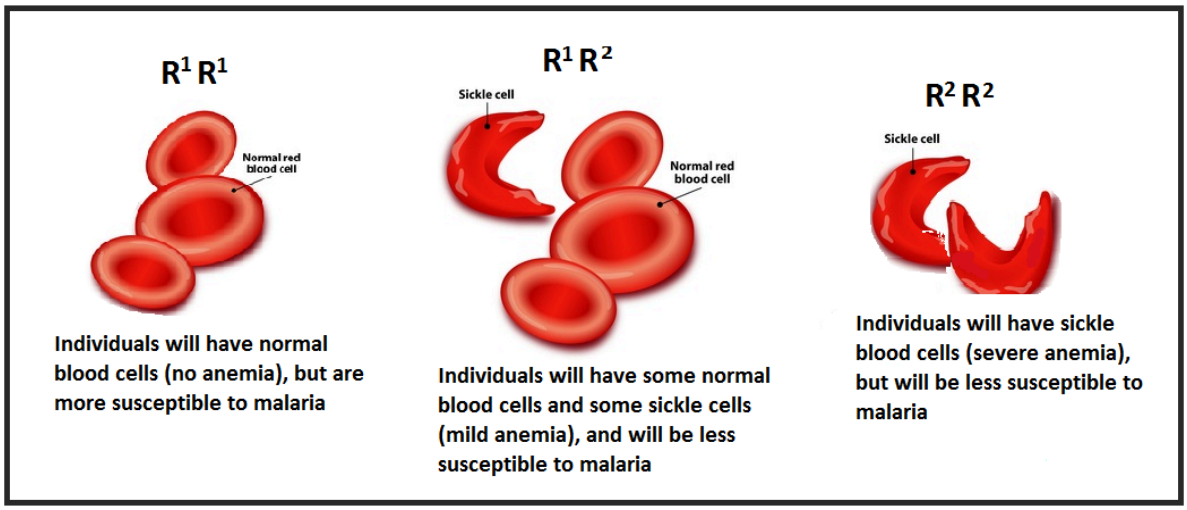
2) Sickle-cell anemia is a genetic disorder of the blood; the severity of this disorder is determined by two alleles which demonstrate incomplete dominance. Individuals with the heterozygous form of sickle-cell anemia actually have an advantage over those who don't in areas where malaria is prevalent...



a. If a homozygous man with normal red blood cells has children with a heterozygous woman, what is the probability that their children will be born with the severe form of sickle-cell anemia? *(Use a Punnett Square to support your answer)*

b. What proportion of the children from the cross described in part "a" will be more likely to survive if exposed to malaria?

CO-DOMINANCE

1) In some varieties of flowering plants, petal colour is determined by two alleles which demonstrate co-dominance. One version of the allele, R_1 , encodes red flowers, while the other version of the allele, R_2 , encodes white flowers.

   a. Determine the phenotype of each of the following plants:

R_1R_1	R_2R_2	R_1R_2

   b. A plant with red flowers is crossed with a heterozygous plant. What proportion of offspring will also have red flowers? *(Use a Punnett Square to support your answer)*

   c. Is it possible for the cross described in part "b" to produce offspring with white flowers? Explain.

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SEX-LINKED TRAITS

1) In humans, color blindness is inherited in an x-linked recessive manner. A colour blind man and a woman homozygous for normal vision have three children: two girls and a boy.

   a. What is the probability that their son is colour blind? *(Use a Punnett Square to support your answer).*

   b. What is the probability that their daughters will both be carriers for the allele that encodes colour blindness?

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   c. What is the probability that they will have colour blind grandchildren?

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   d. What scenario would have to exist for a colour blind man and a woman with normal vision to produce colour blind daughters?

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MULTIPLE ALLELES

1) In humans, blood type is determined by a single gene. However, genotype is determined by three different alleles, whose order of dominance is as follows: $I^A = I^B > i$

   a. Determine all possible allele combinations (genotypes) that could produce each of the following blood types (phenotypes):

Genotypes	Phenotypes
	Type "A"
	Type "B"
	Type "AB"
	Type "O"

   b. Two parents with blood type A have a child with type O blood. What must be their genotypes? Explain.

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   c. A woman who is homozygous for blood type A has a child with a man who is heterozygous for blood type B. What is the probability that their child has type AB blood? *(Use a Punnett Square to support your answer)*

POLYGENIC INHERITANCE

1) Box-and-whisker plots can be used to graph continuous traits caused by polygenic inheritance, such as height or shoe size. These plots demonstrate the variability of data around a median. Consider the following data set...

Student	Shoe size
1	6
2	12
3	10
4	10
5	8
6	9
7	10
8	7
9	8
10	8

a. Distinguish between the mean and the median for the data set above.

b. Construct a box-and-whisker plot for the data set.

GENE LINKAGE

1) In humans, the genes that encode eye colour and hair colour are found very close together on the same chromosome. The allele for brown eyes (B) is dominant to the allele for blue eyes (b). The allele for brown hair (H) is dominant to the allele for blonde hair (h).

   a. A blue-eyed woman with blonde hair has several children with a blue-eyed man who is heterozygous for the hair colour trait. State the expected phenotypic ratio of their offspring IF the genes for hair and eye colour are not linked. *(Use a Punnett Square to support your answer)*

   b. A study which assessed the phenotypes of 100 children produced by couples with the same genotypes as the parents described above yielded the following results:

53	47	0	0
Brown hair & brown eyes	Brown hair & blue eyes	Blonde hair & brown eyes	Blonde hair & blue eyes

   Does this data support the hypothesis that the genes for hair colour and eye colour are linked? Explain.

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Gene Mapping

The relative distance between two linked genes on the same chromosome may be determined using a method known as gene mapping. This requires us to analyze the proportion of offspring with "recombinant" phenotypes in comparison to the total number of offspring...

$$\text{Recombination Frequency} = \frac{\text{number of recombinants}}{\text{total number of offspring}} \times 100\%$$

The recombination frequency of two genes translates to the number of "map units" that separate them on a chromosome.

PRACTICE

Flies can be characterized by a number of traits, including...

- Eye colour, where red eyes (E) are dominant to purple eyes (e)
- Body colour, where black (B) is dominant to grey (b)
- Wing size, where large wings (L) are dominant to vestigial (l)

1) Use a Punnett Square to represent the cross between a purple-eyed fly with vestigial wings and a fly that is heterozygous for both eye colour and wing size. List the predicted phenotypic ratio that would result from this cross if the traits for eye colour and wing size are not linked.

2) A scientist performs the cross described above and obtains the following results. Label each genotype above as either parental or recombinant:

- 40 EeLl
- 40 eell
- 10 Eell
- 10 eeLl

3) Are the genes for eye colour and wing size linked? Explain how you know.

4) How far apart on the same chromosome are eye colour and wing size? (show your work)

5) Two more crosses are conducted, and the following results are obtained:

- Eye colour & body colour are found to have a recombination frequency of 14%
- Body colour and wing size are found to have a recombination frequency of 6%

Given this information, construct a chromosome map for the genes for eye colour, body colour, and wing size in flies.