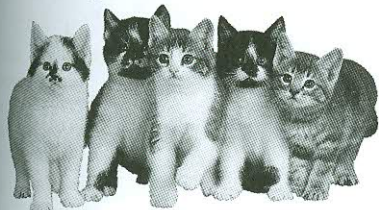


# Sex Linkage

**Sex linkage** occurs when a gene is located on a sex chromosome (usually the X). The result of this is that the character encoded by the gene is usually seen only in one sex (the heterogametic sex) and occurs rarely in the homogametic sex. In humans, recessive sex linked genes are responsible for a number of heritable

disorders in males, e.g. hemophilia. Women who have the recessive alleles on their chromosomes are said to be **carriers**. One of the gene loci controlling coat color in cats is sex-linked. The two alleles, red and non-red (or black), are found only on the X-chromosome.



**Allele types**

$X_O$  = Non-red (=black)  
 $X_O$  = Red

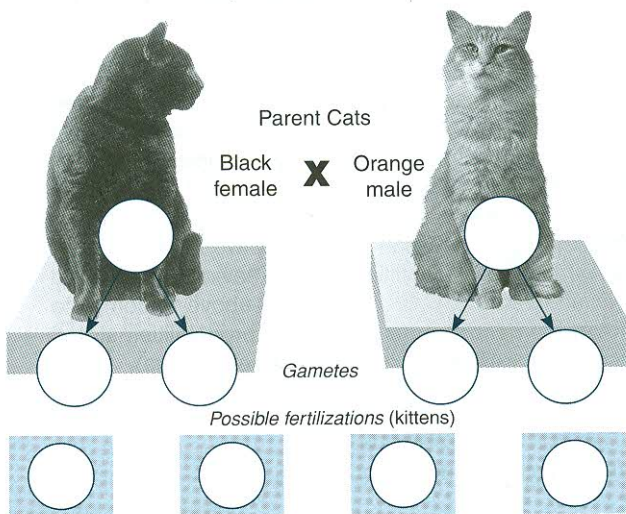
**Genotypes**

$X_OX_O, X_OY$  = Black coated female, male  
 $X_OX_O, X_OY$  = Orange coated female, male  
 $X_OX_O$  = Tortoiseshell (intermingled black and orange in fur) in female cats only

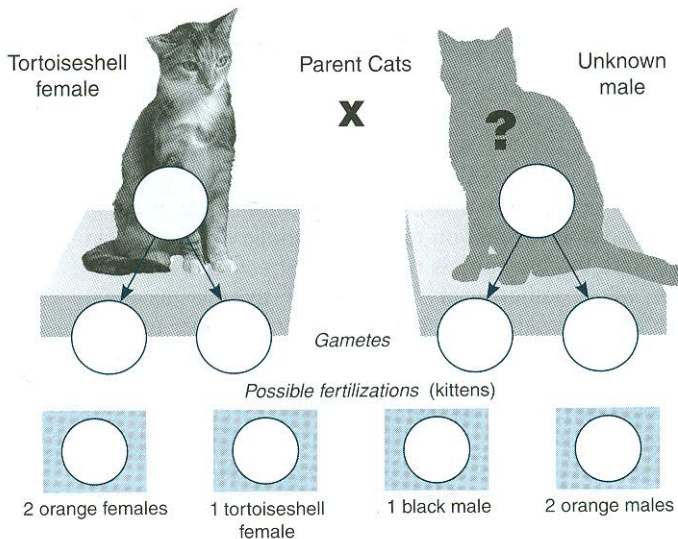
**Phenotypes**

1. An owner of a cat is thinking of mating her black female cat with an orange male cat. Before she does this, she would like to know what possible coat colors could result from such a cross. Use the symbols above to fill in the diagram on the right. Summarize the possible genotypes and phenotypes of the kittens in the tables below.

	Genotypes	Phenotypes
Male kittens		
Female kittens		



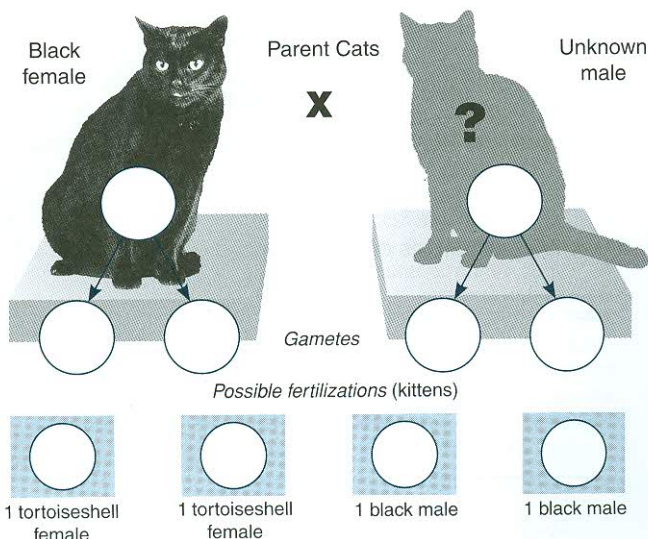
2. A female tortoiseshell cat mated with an unknown male cat in the neighborhood and has given birth to a litter of six kittens. The owner of this female cat wants to know what the appearance and the genotype of the father was of these kittens. Use the symbols above to fill in the diagram on the right. Also show the possible fertilizations by placing appropriate arrows.



Describe the father cat's:

- (a) Genotype: \_\_\_\_\_  
 (b) Phenotype: \_\_\_\_\_

3. The owner of another cat, a black female, also wants to know which cat fathered her two tortoiseshell female and two black male kittens. Use the symbols above to fill in the diagram on the right. Show the possible fertilizations by placing appropriate arrows.



Describe the father cat's:

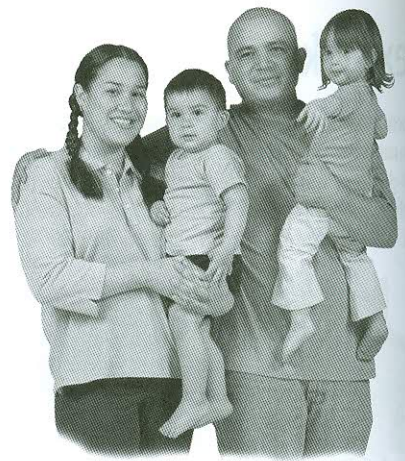
- (a) Genotype: \_\_\_\_\_  
 (b) Phenotype: \_\_\_\_\_  
 (c) Was it the same male cat that fathered both this litter and the one above?  
**YES / NO** (delete one)



# Sex Determination

## Dominant allele in humans

A rare form of rickets in humans is determined by a **dominant** allele of a gene on the **X chromosome** (it is not found on the Y chromosome). This condition is not successfully treated with vitamin D therapy. The allele types, genotypes, and phenotypes are as follows:



### Allele types

- $X_R$  = affected by rickets
- $X$  = normal

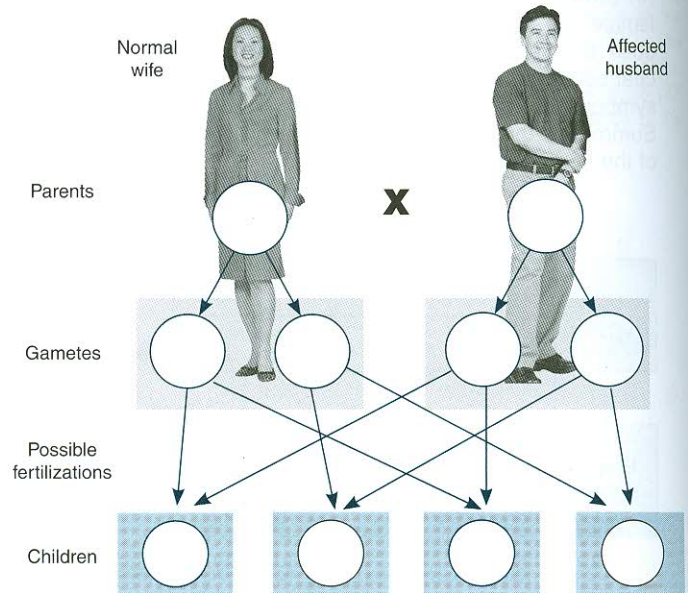
### Genotypes

- $X_R X_R, X_R X$  = Affected female
- $X_R Y$  = Affected male
- $XX, XY$  = Normal female, male

As a genetic counselor you are presented with a married couple where one of them has a family history of this disease. The husband is affected by this disease and the wife is normal. The couple, who are thinking of starting a family, would like to know what their chances are of having a child born with this condition. They would also like to know what the probabilities are of having an affected boy or affected girl. Use the symbols above to complete the diagram right and determine the probabilities stated below (expressed as a proportion or percentage).

4. Determine the probability of having:

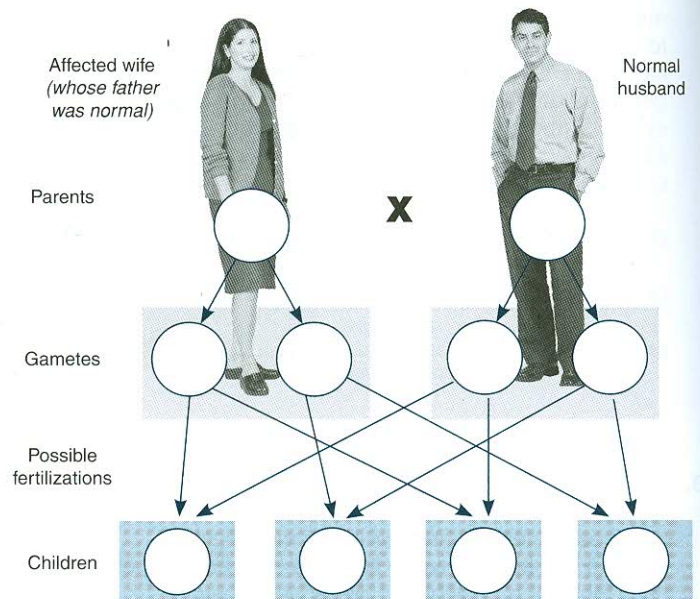
- (a) Affected children: \_\_\_\_\_
- (b) An affected girl: \_\_\_\_\_
- (c) An affected boy: \_\_\_\_\_



Another couple with a family history of the same disease also come in to see you to obtain genetic counseling. In this case the husband is normal and the wife is affected. The wife's father was not affected by this disease. Determine what their chances are of having a child born with this condition. They would also like to know what the probabilities are of having an affected boy or affected girl. Use the symbols above to complete the diagram right and determine the probabilities stated below (expressed as a proportion or percentage).

5. Determine the probability of having:

- (a) Affected children: \_\_\_\_\_
- (b) An affected girl: \_\_\_\_\_
- (c) An affected boy: \_\_\_\_\_



6. Describing examples other than those above, discuss the role of **sex linkage** in the inheritance of genetic disorders:

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