BIOLOGY 121 TARGETED TUTORIALS

**TOPIC: Genetics Problem Solving**

Buckskin horses have a golden yellow coat, bay horses have a red coat, and perlino horses have a coat that is almost white. A series of crosses between the three different types of horses produce the following progeny:

Cross Offspring

buckskin x buckskin 13 buckskin, 6 bay, 5 perlino

bay x bay 16 bay

perlino x perlino 15 perlino

buckskin x bay 8 buckskin, 7 bay

buckskin x perlino 12 buckskin, 10 perlino

bay x perlino 19 buckskin

Explain the inheritance of buckskin, bay and perlino phenotypes in horses. Show how you reached your conclusion.

The inheritance pattern is Incomplete dominance

Homozygotes (bay and perlino) give only one type of offspring, buckskin is heterozygous (any one of the following would be considered a complete answer)

- there are three phenotypes when crossed with other buckskins which correspond to the genotypic ratio

- there are two phenotypes when crossed with either homozygote and the progeny are in a 1:1 ratio

Define alleles : Bay = R, Perlino = L, Buckskin = LR

Bay horses are all homozygous, RR

Perlino horses are all homozygous, LL

Buckskin horses are heterozygous, LR

Note that this cross is the same as a blood type cross, in the case of bloodtypes there are three alleles (A, B & O) and four possible phenotypes (A, B, AB, and O), in this example with the horses there are two alleles and three possible phenotypes.

Having taken some genetics classes, you are approached by a friend who is a cat breeder. She would like to breed cats with wavy hair and no tails. She has documented her attempts and is puzzled by the results. She asks your help in understanding the mode of inheritance of hair characteristics and tail presence or absence. Based on the data collected by your friend, explain the mode of inheritance of each of the traits. Justify your answer with results from specific crosses indicating the genotypes for all individuals in the cross, using gene and allele symbols of your choice.

|  |  |
| --- | --- |
| Parents | Offspring |
| Straight hair, No tail x wavy hair, tail | Wavy hair, no tail = 22  Straight hair, no tail = 26  Wavy hair, tail = 28  Straight hair, tail = 23 |
| Curly hair, No tail x Curly hair, No tail | Curly hair, tail = 23  Curly hair, No tail = 48 |
| Straight hair, no tail x Straight hair, no tail | Straight hair, tail = 37  Straight hair, no tail = 70 |
| Straight hair, tail x Straight hair, tail | Straight hair, tail = 68 |
| Wavy hair, tail x Wavy hair, tail | Curly hair, tail = 8  Straight hair, tail = 11  Wavy hair, tail = 23 |

Begin by separating phenotypes

|  |  |  |  |
| --- | --- | --- | --- |
| Cross | Parents | Offspring | Ratio |
| 1 | Straight hair x wavy hair | Wavy hair = 22 +28 = 50  Straight hair = 26 + 23 = 49 | ~ 1:1 |
| 2 | Curly hair x Curly hair | Curly hair, tail = 23 + 48 =71 | NA |
| 3 | Straight hair x Straight hair | Straight hair = 37 +70 = 107 | NA |
| 4 | Straight hair x Straight hair | Straight hair = 68 | NA |
| 5 | Wavy hair x Wavy hair | Curly hair = 8  Straight hair = 11  Wavy hair = 23 | ~ 1 : 2 : 1 |

Cross 5 – suggests 1 gene 2 alleles – incomplete dominance – wavy are heterozygotes

HS = straight allele

HC = curly allele

HS HS = straight hair

HS Hc = wavy hair

Hc Hc = straight hair

A cross between two heterozygotes gives a genotypic ratio of 1:2:1 – in the case of incomplete dominance where the heterozygote has an intermediate phenotype, the phenotypic ratio is also 1:2:1 which was observed in cross 5 e.g. .

|  |  |  |
| --- | --- | --- |
|  | Parent 1 | |
| Parent 2 | HS | HC |
| HS | HSHS | HSHC |
| HC | HSHC | HCHC |

|  |  |  |  |
| --- | --- | --- | --- |
| Cross | Parents | Offspring | Ratio |
| 1 | No tail x tail | no tail = 22 + 26 = 48  tail = 28 +23 = 51 | 1:1 |
| 2 | Curly hair, No tail x Curly hair, No tail | tail = 23  No tail = 48 | ~1:2 |
| 3 | Straight hair, no tail x Straight hair, no tail | tail = 37  no tail = 70 | ~1:2 |
| 4 | Straight hair, tail x Straight hair, tail | tail = 68 | NA |
| 5 | Wavy hair, tail x Wavy hair, tail | tail = 8 +11 + 23 = 42 | NA |

No tail individuals appear to be homozygous – cross 4 and 5

No tail individuals appear to be heterozygous – cross 1,2,3

Cross of two heterozygotes gives an unusual ration 1:2 not 1:3 – one class appears to be missing – if no-tail was dominant for the tail phenotype but a recessive lethal, a cross between heterozygotes would give a 1:2 ratio of tail:no tail

TN = no tail allele

TT = tail allele

Cross 2 or 3

|  |  |  |
| --- | --- | --- |
|  | Parent 1 | |
| Parent 2 | TN | TT |
| TN | TNTN – Lethal not observed | TNTT –No tail |
| TT | TNTT –No tail | TTTT –tail |

Two no tail : 1 tail

After you determine the mode of inheritance for hair characteristics and tail presence or absence, you perform the following cross and count the progeny. Based on the results of the cross, do the genes assort independently. Justify your answer.

|  |  |
| --- | --- |
| Parents | Offspring |
| Wavy hair, no tail x curly hair, tail | Curly hair, no tail = 50  Curly hair, tail = 4  Wavy hair, tail = 48  Wavy hair, no tail = 1 |

Genotype of parents

HSHC, TNTT x HCHC, TTTT

The HCHC, TTTT parent only produces one type of gamete HCTT

The HSHC, TNTT parent can produce four types of gametes

HS TN

HS TT

HC, TN

HC, TT

Combination of the gametes would produce the four types of offspring seen

HS TN / HCTT = Wavy, no tail (1)

HS TT / HCTT = Wavy, tail (48)

HC, TN / HCTT = Curly, no tail (50)

HC, TT / HCTT = Curly, tail (4)

If genes assorted independently, would expect each of the phenotypes to occur with an equal frequency. Suggests that genes are linked

Draw a cell from the wavy hair, no tail parent at G1, metaphase 1 and metaphase 2. Draw only the chromosomes with the genes of interest. Indicate the alleles on each of the chromosomes.

The non-recombinant progeny are the curly hair, no tail and wavy hair, tail individuals. These inherited non-recombinant chromosomes from the wavy hair, no tail parent.

This indicates that the arrangement of alleles on the homologs are:

HC TN / HS TT -