Genetics, L2 Biology Module provided by: Medjani S,

TD 3 (Transmission of characters)

Exercise 1:

We cross 2 drosophila, purebred for all the genes involved in establishing the phenotype, one with red eyes, the other with white eyes. All the drosophila resulting from this cross (which we call individuals of la F1) have red eyes . The self-crossing (self-fertilization) of the individuals of la F1 gave 330 individuals with red eyes and 112 with white eyes.

1) Determine the number of characters studied and the dominance or recessiveness of the phenotypes studied. Justify each statement.

Number of characteristics studied: only 1 (eye color) (monohybridism).

Dominant character: red eyes

Recessive trait: white eyes

Because all F1 drosophila from this cross of two pure breeds have red eyes (100%) (Phenotypic uniformity of the F1 branch)

In addition, self-crossing of individuals la F1 gave 330 individuals with red eyes (75%) and 112 with white eyes (75%).

Genotypic explanation :

In this case the dominant allele, red, will be noted R; the recessive allele, white, will be noted r.

pure line parents P1 xP2

parents phenotypes red x white

parents genotypes RR x rr

gametes formed R x r

F1 genotype Rr

F1 phenotype 100% [R] red eyes

F1 x F1 Rr x Rr

gametes formed 1/2 R 1/2 r x 1/2 R 1/2 r

Gamete chessboard

F1 gametes / Gametes P2	1/2 R	1/2 r
1/2 R	1/4 RR [Red Eyes]	1/4 Rr [Red Eyes]
1/2 r	1/4 Rr [Red Eyes]	1/4) rr [White eyes]

phenotypes 3/4 (75%) [Red Eyes] 1/4 (25%) [White Eyes]

Now the experimental results of F2 give 330/442 x 100 = 75 % [Red Eyes] and 112/442 x 100 = 25% [[White Eyes]] which corresponds to the theoretical proportions expected from Mendel's monohybrid model .

A cross is made between an F1 female and a white-eyed male.

The experimental results are as follows: 249 individuals with red eyes and 244 individuals with white eyes

2) What is such a crossing called?

Monohybrid test-cross

3) What does it allow to check?

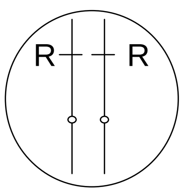
Allows to check if individuals of unknown genotype but presenting the dominant phenotype are of pure lineage (homozygous) or not (heterozygous) for a given characteristic.

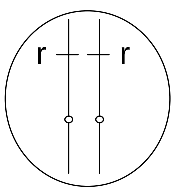
4) Using reasoning based on chromosomal representations and the writing of genotypes, test the two hypotheses and then conclude.

Hypothesis 1: if F1 was homozygous for the R allele (RR genotype)

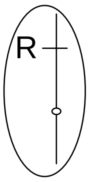
In this case the dominant allele, red, will be noted R; the recessive allele, white, will be noted r.

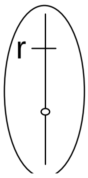
F1	x	P2	Test-cross
[red]	x	[white]	parents' phenotypes





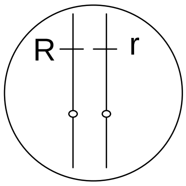
chromosome trim





gametes formed

100% [R] red eyes — F1 phenotype



chromosome trim

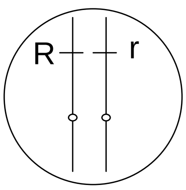
Rr — F1 genotype

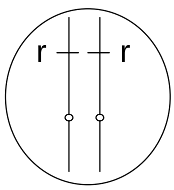
100% [Red] — phenotypes

However, the experimental results give 249/493 x 100 = 50% [R] and 244 /493 x 100 = 50% [r] which does not correspond to the expected theoretical proportions.

Hypothesis 1: if F1 was homozygous (Rr genotype)

F1	x	P2	Test-cross
[Red]	x	[white]	phenotypes





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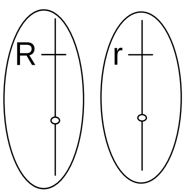

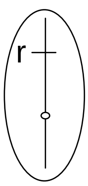

gametes formed

1/2 R 1/2 r		r	gamete genotypes

F1 gametes / Gametes P2	1/2 R	1/2 r
r	1/2 Rr	1/2 rr
phenotypes	½ (50%) [Red]	½ (50%) [white]

Gamete chessboard

However, the experimental results give 249/493 x 100 = 50% [R] and 244 /493 x 100 = 50% [r] which corresponds to the expected theoretical proportions.

So we conclude that F1 is heterozygous which is logical since it comes from a cross of two pure lines.

Exercise 2:

A genetic model has been proposed to explain the inheritance of right-handedness or left-handedness in humans (laterality). This model is as follows: the quality of being right-handed or left-handed is controlled by a gene with two alleles: - allele R Contribution to the right-handed phenotype (dominant)

- allele r undetermined laterality (recessive)

SO :

RR or Rr **genotype** gives right-handed **phenotype**

genotype rr gives an indeterminate laterality: half of these children become left-handed individuals and half become right-handed.

1) Based on this model, two Rr (right-handed) parents have a 1/8 chance of having a left-handed child. Explain why this is so.

A Rr X Rr cross gives a 1/4 chance of having a rr child and the rr child has a 1/2 chance of being left-handed. Therefore, the chance of being left-handed is 1/4 x 1/2 = 1/8.

2) According to this model, can a left-handed mother and a right-handed father have a left-handed child? Justify your answer.

The left-handed mother's genotype is rr . The right-handed father's genotype can be Rr or rr .

1) A left-handed mother (rr) and a right-handed father (Rr) have a half chance (1/2) of having a child rr and this child has a half chance (1/2) of being left-handed. Therefore, the probability that this child is left-handed is 1 / 2 x 1 / 2 = 1/4.

P rr X Rr

G r X 1/2R 1/2r

F1 50% Rr 50% rr

100% right-handed (1/2 would be right-handed, 1/2 would be left-handed)

So in the end 75% right-handed and 25% left-handed

1) A left-handed mother (rr) and a right-handed father (rr) can only have one rr child who has a half chance of being left-handed.

P rr X rr

G r X r

F1 100% rr

So in the end 50% right-handed and 50% left-handed

2) According to this model, can two left-handed parents have a right-handed child? Justify your answer.

As noted above, a left-handed mother (rr) and a right-handed father (rr) can have an rr child who has a half chance of being right-handed.

Exercise 3:

In a hybridization experiment, if the allele for long-stemmed plants (T) was incompletely dominant over the allele for short plants (t),

1) What would be the result of crossing a homozygous long-stemmed plant (pure line) and a homozygous short plant?

P TT X tt

G T X t

F1 100% Tt

Heterozygous (Tt) offspring would have a stem of intermediate length.

2) What would be the result of crossing two heterozygous plants?

P Tt X Tt

G 1/2T 1/2t X 1/2T 1/2t

F1

Gametes P1 / Gametes P2	1/2 T	1/2 t
1/2 T	1/4 TT	1/4Tt
1/2 t	1/4Tt	1/4tt

Ratio 1:2:1

1/4 will have the dominant phenotype (long stem, TT), 1/2 will have the intermediate phenotype (Tt) resembling the parents of this cross (intermediate length), and 1/4 will have the recessive trait (short stem, tt.)

When dominance is incomplete, it is not necessary to do a test-cross to identify heterozygotes.

Exercise 4:

codominant alleles . There are three different alleles , known as I^A, I^B, and i. The I^A and I^{B} alleles co - dominate, and the i allele is recessive. Possible human phenotypes for blood group are type A, type B, type AB, and type O.

What are the possible blood types of children from a marriage between a type AB woman and a type O man?

The woman has blood type AB, her genotype is $I^A I^B$. The man has blood type O, his genotype is ii. They can have children who are either I^Ai or I^Bi . Their blood type will be either A or B.

Female parents (group AB) $I^A I^B$ X ii man (group O)

Gametes 1/2 I^A 1/2 I^B X i

F1 I^Ai (group A) I^Bi (group B)

What are the possible blood types of children from a marriage between a type A woman and a type O man?

The woman has blood type A, her genotype is $I^A I^A$ or I^Ai . The man is blood type O, his genotype ii. So two possibilities.

Possibility 1

Female parents (group AB) $I^A i$ X ii man (group O)

Gametes 1/2 I^A 1/2 i X i

F1 $I^A i$ (group A) ii (group O)

Possibility 2

Parents female (group AB) $I^A I^A$ X ii male (group O)

Gametes I^A X i

F1 $I^A i$ (group A)

They can give birth to children who are either $I^A i$ or ii. Their blood type will be either A or O.