Full Name:	Civics group:	Index no.:	Date:
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Core Idea 2: Genetics and Inheritance Dihybrid cross & Test Cross

Tutorial 13

QUESTION 1

A homozygous white-flowered, long-stemmed tobacco plant, *Nicotiana affinis*, was crossed with homozygous pink flowered, short-stemmed plant. The alleles for white flower and long stem are dominant to those for pink flower and short stem.

The above cross gave rise to the F1 generation. The F1 plants were selfed to produce the F2 generation. Using suitable symbols, construct a genetic diagram to illustrate the outcome of the above crosses.

.....[6]



QUESTION 2

In rumbunnies, facial warts (W) is dominant to smooth face (w) and freckled face (F) is dominant to freckle-less face (f). Rumbunnies that are heterozygous for both facial warts and freckles were crossed with smooth-faced and freckle-less rumbunnies.

The resultant offspring were as follows:

Phenotype	No. of rumbunnies
Wild phenotype (facial warts, facial freckles)	45
Facial warts, freckle-less	48
Smooth face, freckle-less face	46
Smooth face, Facial freckles	51

(a) Draw a genetic diagram to show the cross described.

.....[5]



(b) If you are given a Rumbunny with Facial Warts and Facial Freckles, explain how you would derive its actual genotype.



QUESTION 3

Fruit flies (*Drosophila melanogaster*) have been used extensively in investigation of inheritance. They are particularly suited to study because of their short life cycle and many different mutant forms. In one investigation, red-eyed females with grey bodies were crossed with brown-eyed males with black bodies. All the F1 generation had red eyes and black bodies.

When these F1 flies were crossed, the following offspring were produced:

Phenotype	No. of flies
Red-eyed, black-bodied	110
Red-eyed, grey-bodied	39
Brown-eyed, black-bodied	37
Brown-eyed, grey-bodied	13

(a) State the dominant characters for eye color and body color.

.....[1]

(b) State the genotypes of the parent flies, using suitable symbols.

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		[0]

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(c) Draw a genetic diagram to show how the F2 offsprings were produced.





(d)	Determine the results of a test cross conducted on the F1 offsprings.	
	[[5]



Genetics & Inheritance Codominance, incomplete dominance, multiple alleles, sex-linked genes

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Pedigree trees, based on their traits, can be classified into 4 inheritance patterns:

- 1 Autosomal recessive traits
- 2 Autosomal dominant traits
- 3 X-linked recessive traits
- 4 X-linked dominant traits



(Important ! The following table has been compiled to assist you to quickly identify the mode of inheritance in pedigrees but you will **still need to perform a genetic analysis to confirm your prediction**)





Revision on Symbol Representation:

Scenario	Representation	Example
Co-dominance	Allelic symbols (B vs P vs Y) should be superscripted against a base gene alphabet e.g. C	C^{B}, C^{P}, C^{Y}
Incomplete dominance	Allelic symbols (B vs b) should be superscripted against a base gene alphabet e.g. C	C^{B}, C^{b}
X-linked condition (with one allele dominant to another)	Allelic symbols (e.g. N, n) should be superscripted against the letter X (representing X chromosome).	X ^N , X ⁿ , Y
	Y chromosome has no corresponding allele for the same gene	
X-linked condition with 2 co- dominant alleles	Allelic symbols (e.g. B, G) should be superscripted against the letter X (representing X chromosome). Different allelic symbols are used instead of capital letter vs small letter, because of co-dominance. Y chromosome has no corresponding allele for the same gene	<i>Х^в, Х^G,</i> Ү



QUESTION 4 [MULTIPLE ALLELES] [Time : 12min]

The background colour of the shell of the snail *Cepaea nemoralis* may be brown, pink or yellow. The colour is controlled by a **single gene locus with three alleles**.

 C^{B} codes for brown and is dominant to C^{P} which codes for pink. C^{Y} codes for yellow and is recessive to both of the other alleles. What will be the expected phenotypic ratios in the offspring of the following crosses?

(a) Heterozygous pink X yellow

.....[3]



QUESTION 5 [SEX-LINKAGE AND CO-DOMINANCE]

Coat colour in cats is determined by a **sex-linked gene** with two alleles, black and ginger. In a particular colony of cats, the coats of the males were either black or ginger and those of females black, ginger or **tortoiseshell** (a patchwork pattern of black and ginger).

(a) Using appropriate symbols, state the genotypes and phenotypes of the observations.



(b) In a litter of kittens, half the number of females was tortoiseshell and the other half were black; half the number of males was black and the other half were ginger.

What were the colours of the parental male and female? Explain your answer with the help of a genetic diagram.



QUESTION 6 [SEX-LINKAGE]

Red-green colour blindness is the inability to distinguish between the colours red and green. The genes that determine colour vision is located on the **X chromosome**. The allele for normal vision is dominant to that for colour blindness.

- (a) A woman with normal colour vision, whose father was red-green colour blind, married a red-green colour blind man.
 - (i) Show with the help of genetic diagram, the **probability** that a girl born to this couple being red-green colour blind.

.....[4]



Additional Questions:

(ii) What is the probability that this couple give birth to a child who is a red-green colour blind girl?

......[1]

(iii) What is the probability that their first son will be colour blind?

.....[1]

(iv) What is the probability that this couple give birth to a **second child** who is a **colour blind boy**?

.....[1]

(v) The couple has 4 sons. What is the probability that **all four sons** will be **colour blind**?

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(vi) What is the probability that this couple give birth to 4 colour blind sons?

.....[1]

(vii) With reference to the following table, explain the occurrence of female sufferers of red-green colour blindness.

Condition	Details	% male sufferers	% female sufferers
Red-green colour blindness	Inability to distinguish between red and green	8.0	0.70
Haemophilia	Blood fails to clot properly	0.10	Less than 0.01
Duchenne muscular dystrophy	Poor muscular development	0.25	Less than 0.01



(b) Explain why the incidence of red-green colour-blindness, in both males and females, is higher than that of the other 2 conditions.

.....[1]

[Total: 13]

QUESTION 7 [MULTIPLE ALLELES & PEDIGREE] Adapted from 2012 SAJC FE

(a) Fig. 7.1 below shows the inheritance of blood group of a family through three generations.



The inheritance of the blood type is controlled by a single gene with multiple alleles. Some of these alleles code for antigens on the cell surface membrane of the red blood cells.

(i) Explain what is meant by multiple alleles.



(ii) Use one piece of evidence shown in **Fig. 7.1** to explain clearly which individual's blood group may have been typed wrongly.



Continuous & Discontinuous Variation

QUESTION 8 [9648/P2Q5/2010]

A cross was made between two varieties of tobacco, *Nicotiana*, with short-tubed corollas and long-tubed corollas.

Fig. 8.1 opposite shows the variation in corolla tube length of the parental forms and the first generation (F_1) and second generation (F_2) of offspring.



(a) State the term used to describe the range of phenotypes in the second generation (F_2) of offspring.

.....[1]

(b) Explain why there is a range of phenotypes for this characteristic.



(c) Suggest why the range of variation is greater in the second generation (F₂) of offspring than in either the first generation of offspring (F₁) or the parental phenotypes.

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[4]

[Total: 9]