

Introductory **GENETICS**

**BBC
Model B**

by Colin Pearson



GARLAND EDUCATIONAL SOFTWARE

INTRODUCTORY GENETICS

by Colin Pearson

for the BBC Microcomputer (32k)

Introduction

This is a multi-program package designed to assist the understanding of elementary concepts in genetics, for pupils aged 13 - 16 (from lower-ability CSE to 'O' Level). The programs contain all necessary instructions for operation on-screen, and also employ extensive error-trapping routines, making them particularly suitable for introducing genetics to younger or lower ability pupils. No manual is required by the user, but this booklet is intended to provide the background and details of the programs for the teacher. You are advised to read these notes carefully and run through the programs several times before using them with pupils. Teachers may wish to prepare worksheets and students' notes for use in conjunction with the programs.

The programs may be used in three ways

- (a) for computer-assisted learning by an individual - using worksheets if desired after a first viewing
- (b) on a large monitor, with one pupil assigned to work the keyboard and to interact by a consensus of the class
- (c) for the teacher to use some or all of the simulations and base his/her lesson around these - using the computer as an interactive visual aid.

Instructions for Use

The program is available on disc only. Please check that you have a disc of the correct format for your disc drive (40 or 80 track).

TO LOAD insert the disc (in drive 0 if you have a dual drive), and press and release the BREAK key while holding the SHIFT key down. This automatically loads the title pages, followed by the main menu. Programs and files are loaded from the disc as required during operation of the program. Make sure that the CAPS LOCK light is illuminated when you start each program. In some cases routines are included to allow either upper (CAPS on) or lower (CAPS off) case entries, but when entering genotypes, you must use the appropriate type. Reminders are given to check for this.

The main menu allows you to select one of three main titles

1. Sex Determination
2. Dominance and Co-dominance
3. Inheritance of Blood Groups

Press the number corresponding to the chosen topic. If you wish to leave the programs, select option 4 (Exit). Note that most keyboard entries throughout this package are single-key entry. There is therefore no need to press RETURN, except where specifically told to do so by instructions in the program.

SEX DETERMINATION

The objectives of this title are to assist in learning the following

- (a) Sex determination is controlled by two chromosomes called X and Y
- (b) A female cell contains two chromosomes - XX. A male cell contains an X and a Y chromosome.
- (c) Only one sex chromosome is present in each gamete. All ova must contain an X chromosome. Sperm contain either an X or a Y chromosome.

(d) If a sperm containing an X chromosome fuses with the ovum, then the fertilised ovum (XX) will develop into a girl. If a sperm containing a Y chromosome fuses with the ovum, the the fertilised ovum (XY) will develop into a boy.

(e) There is an equal probability of producing male and female offspring.

(f) The more offspring that are produced, then the nearer the observed result should be to the expected result.

On selecting Option 1 from the main menu, you will be presented with a sub-menu. If you have not used the program before, proceed by pressing the SPACE BAR so that you may work through the entire program in sequence. On subsequent use of the program, you may wish to go direct to a particular section, by pressing the appropriate letter key as indicated.

O. Oviduct Simulation

This option explains how the sex of an individual is determined by the X and Y chromosomes. Following the text, some TRUE/FALSE questions are used to test understanding - answers are entered by keying T or F. You will be told if your answer is correct, or if incorrect an explanation will be given. At the end, you will be retested on those questions you answered wrongly, and the program will not continue until all are answered correctly. This is followed by a graphical simulation of the the fertilisation of an ovum by a single sperm in the oviduct. If you wish to stop the movement of the sperm towards the ovum, this can be done by pressing any key. At random, either an X or a Y sperm will reach the ovum first and fertilise it. You will then be asked if the offspring will develop into a boy or a girl (press B or G). This is followed by a series of questions which reinforce the concept that there is an equal probability of a male or female developing, depending on whether an X or Y chromosome is contained within the sperm. If an incorrect answer is given, you may choose either to repeat the simulation, or to continue (press the SPACE BAR).

G. Genetic Cross

This sequence demonstrates in a different way how sex is determined. Here, gametes are shown being produced at random, fusing and then placed in a column according to sex. A running total of the number of boys and girls is given. Up to 18 offspring will be produced. You will then be asked how many of a particular sex would be expected. This will reinforce the concept of equal probability of male or female resulting, but also shows how deviation from this can occur if small samples are examined.

F. Families

This sequence uses the names of parents with varying numbers of children, and illustrates how small sample size may lead to deviation from the expected equal number of male and female offspring. An obvious extension of this approach is for the pupils to obtain and analyse data about their own families.

L. Lots of Offspring

This section allows you to take successive samples of twenty offspring. These are shown pictorially (as boy or girl figures), in a table showing the current sample and the running total and in a graph showing the cumulative total. This option should lead to an understanding of how individual small samples of offspring can lead to deviations from the expected 50:50 ratio but how the expected ratio is more likely as the size of population sampled is increased. Each sample is selected by pressing the SPACE BAR. If R is pressed, the values will be reset from sample 1.

To complete the program, press F and a final summary of the key points in the program are given. Teachers should note that the program assumes throughout that the ratio of male:female offspring is always 50:50, as predicted by the behaviour of the gametes. There are in fact seasonal and other deviations from the expected ratio, due to such factors as different viability of X and Y sperm and different viability of male and female embryos. Artificial selection of sex has been used in animal breeding and may become possible in humans. The ethical and social implications of this could form an interesting point for discussion with pupils.

DOMINANCE AND CO-DOMINANCE

This title is intended to familiarise the user with the concepts of genetic notation and of dominant, recessive and co-dominant genes. Having set up the characteristics and genes of the parents, the results of any cross can be investigated. A clear representation of the way in which random fusion of gametes gives rise to offspring with different genotypes is given. There is also the option of a test to assess understanding of dominance and co-dominance, where you must relate the letters relating to dominance and co-dominance, and work out the expected percentages of genotypes in the progeny.

On selecting this title from the main menu, press key I if you wish to set up and investigate crosses, or press key T for the test. To return to the sub-menu page at any time during the programs, press ESCAPE. You can return to the main disc menu by choosing option M.

I. Investigating Crosses

You must first choose the characteristics (phenotypes) and genes, with the dominant characteristic given first. A flashing ? indicates that the program is waiting for an entry. Type in the first characteristic (up to six letters) followed by RETURN - for example, you might enter Tall. Then enter the code for the first gene (in this case T). If a lower case entry is made for the first gene, this will be corrected - the convention used being that the gene must be given the capital initial of the dominant characteristic. You then enter the second characteristic (e.g. short), followed by the code. If you wish the second gene to be recessive (for example t), then you must switch the CAPS LOCK off. The program will then assume that the first gene is dominant to the second. Otherwise, co-dominance will be assumed, in which case you will be asked to enter the characteristics of the heterozygote (abbreviated if necessary). For example, you might enter Red (R) and White (W), with Pink for the heterozygote (RW).

You may then investigate the proportions of offspring produced by parents carrying your chosen genes, by performing crosses. You are asked if you wish to choose

the genotypes of the parents yourself, or if you wish the computer to choose parents at random. You then have the choice of seeing the results of the cross displayed in one of two ways. In the first (G) you will be shown the gametes arising at random and being placed in columns according to phenotype. A maximum of 8 offspring can appear in one column, and since this number is very low, it is likely that the ratios observed will differ markedly from the ratio predicted by random assortment. With the histogram option (H), up to 100 offspring may occur in a column so that the observed ratio is likely to be closer to the expected - a chi-squared test can be used to verify this. In both of these options you can speed up the generation of offspring by pressing key S. After a cross, you can choose to make further crosses, or change the genes.

After selecting the characteristics and genes, it is possible to select the situation in which the double dominant genotype is lethal. This option can be obtained by the teacher pressing ? In this case, the proportion of progeny produced will be affected accordingly. If you use this option it is best to select the histogram option first.

T. The Test

On selecting this option, your understanding of dominance and co-dominance will be tested using two imaginary species of rose. Species 1 has red colour (R) dominant to white (r), while in species 2 red (R) and white (W) are co-dominant. To practice, you can choose the parental genotypes, or select for them to be generated at random. The cross will be shown on screen, and you must enter the expected percentage offspring with each phenotype (red, white or pink). Enter a number when the flashing ? appears - there is no need to press RETURN. The total of percentages entered must be 100 - if not you will be corrected and must try again. If you select the graded test you will be given five crosses (from a possible 288) and a score given at the end. In all cases you will be shown a table with the entries you made, the entries the computer expected (the correct answer), and the 'actual' result obtained as a result of performing the cross by random generation of gametes.

INHERITANCE OF BLOOD GROUPS

This title is intended to familiarize the user with the genetics of the ABO human blood groups. You are given information about the alleles and invited to work out the possible genotypes, then to sort genotypes into blood groups. The results of crosses can be investigated, and understanding assessed with a test.

On selecting this title for the first time, use the SPACE BAR to move to the full program - on subsequent use it is possible to go direct to any of the sections by choosing the appropriate letter from the menu. Pressing ESCAPE at any time will bring you back to the title menu.

W. Working out genotypes

Brief information is given about the A, B and O alleles. You are then asked to enter the possible genotypes which can occur, with each entry followed by RETURN. Each input is error searched and errors are corrected (up to 32 wrong attempts will be allowed - then the input will be automatically completed). When all possible genotypes (i.e. six) have been entered, enter C followed by RETURN.

G. To sort genotypes into blood groups

You are told that A and B are co-dominant, that A and B are dominant to O, and that there are four blood groups based on this. You must then give the possible genotypes for each blood group. As before, the entries are searched for various types of error but in addition, if a correct genotype is placed in a wrong blood group there is a constructive comment made.

P. The practice game

Here a cross will be set up between random parents the gametes will be shown combining, and you must direct the offspring into the appropriate box on the screen, according to blood group. This is done using the arrowed cursor control keys (left, right, up, down). This can be repeated as often as desired.

I. To investigate crosses

This section is essentially similar to the sequence in the Dominance and Co-dominance program. As before, you can choose to set up the genotypes of the parents yourself, or to accept randomly generated parents, and to display the results in columns (up to 8) or histograms (up to 100).

T. The test

This also follows a similar format to the Dominance and Co-dominance program. You must enter the expected percentage of offspring with a particular blood group resulting from certain parents. As before, you can choose the parents, accept them as generated by the computer, or attempt a graded test in which a score (out of 5) will be given. All 4800 possible combinations are possible in this test.

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Introductory GENETICS

A collection of ten interactive programs designed to assist the understanding of elementary concepts in genetics for CSE and 'O' Level courses (age 12+).

SEX DETERMINATION contains four programs which help in understanding how male and female offspring are produced during reproduction, and includes simulations of fertilisation of the ovum by sperm, and the random production of male and female gametes.

DOMINANCE AND CO-DOMINANCE contains two programs which allow the user to investigate the results of any cross for single factor inheritance controlled by two alleles. A test requiring relation of gene letters to dominance and co-dominance and working out expected ratios is included.

INHERITANCE OF BLOOD GROUPS contains two programs based on the inheritance of A, B and O alleles. The user works out possible genotypes and can investigate the results of any cross. A test at the end of the program is based on working out expected percentage offspring.