

Activity 2.16 Reebops

Purpose

- To examine how characteristics are inherited.
- To illustrate one of the ways in which meiosis is responsible for the tremendous variation that exists in every sexual species.

Breeding Reebops

'Reebops' are imaginary animals, made out of marshmallows, pins and cocktail sticks! They have 16 chromosomes (eight pairs) in their body cells.

Have a look at the parent Reebops. Note their characteristics, such as number of body segments, antennae, etc. Both parents show the same features, except of course one is male and the other is female.

You are going to carry out a breeding programme, using the same procedures as in a breeding programme with real organisms, and applying the same rules that are found in genetics.

Read the information sheets before you start. It is important that you understand what happens to form the **gametes** or sex cells.

Safety

Do not eat the Reebops.



Procedure

- 1 You are provided with two envelopes. One contains Reebop Mum chromosomes and the other contains Reebop Dad chromosomes. There are 16 chromosomes (eight pairs) in each envelope. Open the envelope and take out the pack of cards.
- 2 Turn the chromosome cards face down, so that you cannot see the genotypes (letters) on them. Keep the Mum and Dad chromosomes separate, so that you have two groups of cards.
- 3 In each group of cards sort them into pairs of the same length.
- 4 Now randomly take one chromosome of each paired length from the Mum chromosomes and place in the 'female gamete' pile. Repeat for each pair of Dad chromosomes and place them in the 'male gamete' pile.
- 5 Now carry out 'fertilisation' by mixing the female gamete and male gamete piles to form a 'baby gene' pile.
- 6 Put the remaining chromosomes back into the envelopes.

You have now carried out sexual reproduction, whereby half the chromosomes from one parent have been randomly mixed with half from the other parent to make a unique combination. Note that each parent donated half the chromosome number (eight) that the adult cells contain, i.e. 16. Meiosis is responsible for halving the chromosome number in gametes so that when gametes combine at fertilisation, the correct number is present in the new individual.

- 7 Now, write in the genotype grid the letters that you have obtained in your 'baby genes'. For example, if you have one card with the letter **A** and another one with the letter **a**, put **Aa** in the box for antennae, etc. When you have completed all the features in the grid, you are ready to assemble your baby Reebop! Refer to the genotype decoding key to check what characteristics your baby has inherited. Collect

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all the necessary body parts that your baby possesses. For example, if it has the genes **BB**, you will need three white marshmallow body parts. Join them together with two cocktail sticks.

Table 1 Genotype decoding key.

Antennae	AA = 2 antennae	Aa = 2 antennae	aa = no antennae
Body segments	BB = 3 body segments	Bb = 3 body segments	bb = 2 body segments
Tail	TT = curly	Tt = curly	tt = straight
Nose	NN = red nose	Nn = orange nose	nn = yellow nose
Legs	LL = blue legs	Ll = blue legs	ll = red legs
Sex	XX = female	XY = male	
Eyes	EE = 2 eyes	Ee = 2 eyes	ee = one eye
Humps	HH = 1 hump	Hh = 1 hump	hh = 3 humps

- 8 Assemble all the features that your baby possesses, and check that you have not made a mistake (mutated a part!).

Now place your baby in the nursery provided. Have a look at the other babies present. Remember that all the Mum Reebops had the same chromosomes as one another and that each Dad Reebop had the same chromosomes as the other Dads.

Questions

- Q1** What do you notice about the features that the babies have?
Q2 Are there any babies that are identical?
Q3 How many are the same as their parents? Which parent?
Q4 How much genetic material does each parent provide?
Q5 Where is this genetic material in the parent?

Extension

You may wish to extend this exercise further by choosing two babies, which then grow up rather rapidly, and are themselves used as parents for the next generation of Reebops.

Draw up a family tree to show how some of the original features are inherited.

Another idea would be to introduce a recessive mutation for some feature, and see how that is passed on in subsequent generations.

Record your baby Reebop genotype and phenotype in this type of table.

Table 2 Phenotype table.

Characteristic	Allele from Mum	Allele from Dad	Phenotype
Antennae			
Body segments			
Tail			
Nose			
Legs			
Sex			
Eyes			
Humps			

Genetics information sheet

All cells contain hereditary information that is encoded by a chemical called **DNA** (deoxyribonucleic acid). DNA is an extremely long molecule, with up to a metre in every cell (Figure 1). When a DNA molecule is all coiled up and bunched together it is called a **chromosome**.

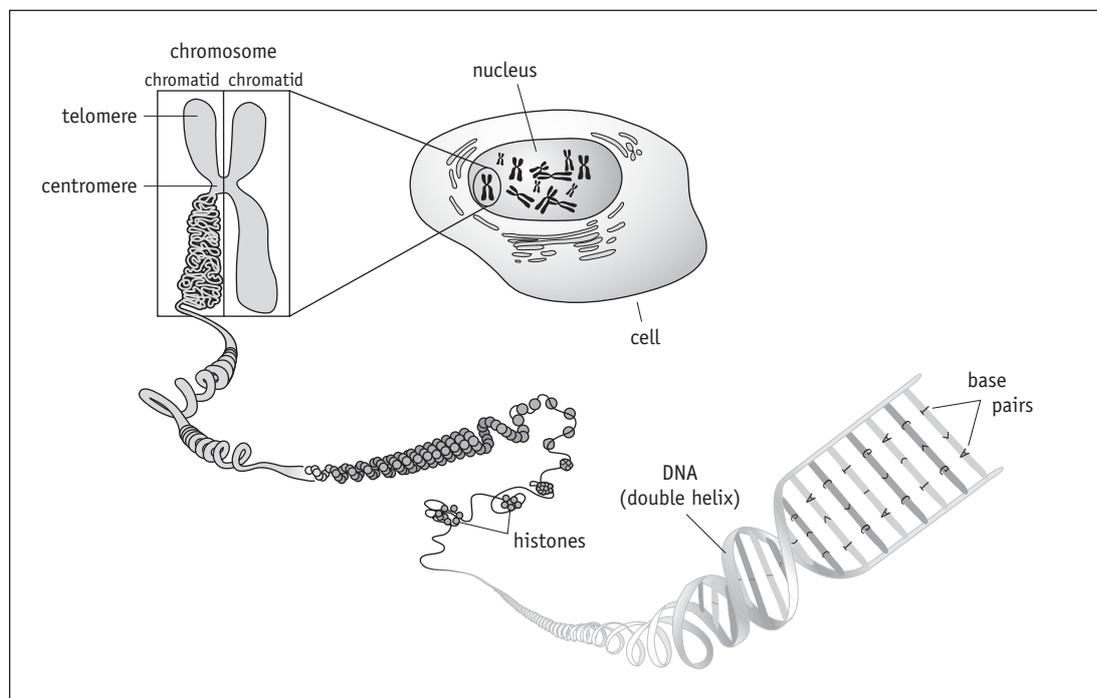


Figure 1 DNA is coiled up to fit into the nucleus.

Each chromosome has a separate molecule of DNA, so a cell with eight chromosomes has eight molecules of DNA. A **gene** is a segment on a DNA molecule. Different genes may be very different lengths. Each gene codes for a certain protein molecule, which is then made in the cell cytoplasm. The proteins produced by the genes can generally be sorted into two different types: ones that run the chemical reactions in the body, and ones that will be the structural components of the body. How an organism looks and functions are a result of the cumulative effect of all of these proteins. (It is worth noting that some genes code for RNA that is never translated into protein, for example tRNA and rRNA.)

Chromosomes can be seen if you look through a microscope at a cell stained with a special stain (you may do this in Topic 3).

The DNA in a cell coils up to form chromosomes just before the cell divides.

Any organism that has 'parents' has an even number of chromosomes, because one half of the chromosomes come from the 'father' and the other half from the 'mother'. For example, in plants, a cell in a pollen grain is the 'father's' contribution and an ovule is the 'mother's' contribution. These two cells combine to make a single cell, which grows into a seed (the offspring). Humans have 46 chromosomes sorted into 23 pairs. One chromosome in each of the 23 pairs is from the person's father, the other from the person's mother.

Since chromosomes come in pairs, genes do too. One gene is located on one member of a chromosome pair; the other gene is in the same location on the matching chromosome.

The precise location where the gene is found on the chromosome is referred to as its **locus**.

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A gene can consist of a variety of different forms, but only two forms are ever present in an individual (one from the mother, the other from the father). Both members of the pair contribute to the same feature, such as having hair on the middle segment of your fingers.

The two different gene forms on the pair of chromosomes may be identical or different. For example, in the Reebops activity the gene for tail shape has a **T** form and a **t** form. If both chromosomes have a **T** form, or if both have a **t** form, the gene is said to be **homozygous** (two of the same form). If one chromosome has a **T** form and the other has a **t** form, the gene is said to be **heterozygous** (two different forms).

The different forms that comprise a gene are called **alleles**. Therefore, **T** and **t** are alleles for the tail shape gene.

If you look at the Key to Reebop features, you will notice that two **Ts** (**TT**) or a **T** and a **t** (**Tt**) code for the same thing: a curly tail. If the Reebop has a small **t** on each chromosome, he or she will have a straight tail. Because both the heterozygous (**Tt**) form and one of the homozygous (**TT**) forms code for the same variation of tail shape, curly tail is said to be the **dominant** variation and straight tail the **recessive**. In humans, the allele for hair on the middle segment of the fingers (**H**) is dominant to the allele for no hair (**h**).

If an expectant mother chooses to have an **amniocentesis**, she will learn some information about her baby's chromosomes, but not about the baby's genes. Chromosomes are large enough to be seen with a light microscope, but genes are not. Specialised tests are required to look for a particular gene that can cause a genetic disorder.

Amniocentesis is used to see if a baby has the correct number and length of chromosomes. The chromosomes of fetal cells taken from the amniotic fluid are examined under a light microscope. The baby's chromosomes are then photographed and cut up to make visual sorting easier. Each pair of chromosomes differs in length. The chromosomes that have been cut out of the photo are then arranged, by length, into the 23 pairs. The pairs are numbered longest to shortest, with the longest pair labelled as number one. This chromosomal picture is called a **karyotype** (Figure 2).

If a mistake occurs when cells are dividing to produce egg or sperm cells, the baby may end up with an incorrect number of chromosomes. This error would show up in the karyotype.



Figure 2 A human karyotype.