

Changes, great and small

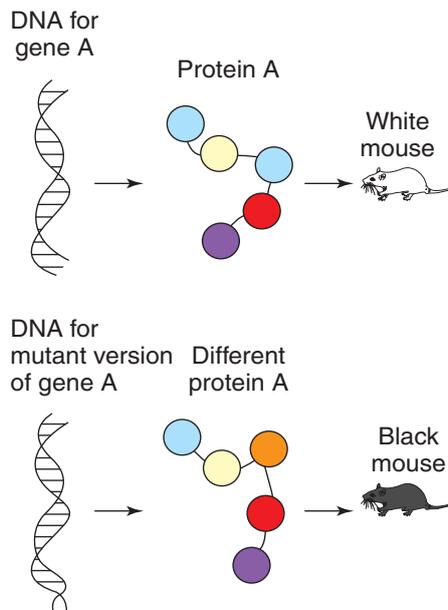
It's one thing to explain small scale genetic change such as how finches evolved different beaks, but does Darwin's theory account for how they became separate **species**? Most scientists believe that small genetic changes over millions of years result in the **evolution** of new species.

Mutation

Many of the differences between individuals are the result of differences in their genetic blueprint, their **genes**. The **DNA** in genes acts as a code to control production of different proteins. Proteins have many roles in living things, including enzymes that affect growth, the production of pigments (e.g. skin, hair, eye, flower colour, and photosynthetic pigments), digestive enzymes, cell structures, the immune system and many others.

A change in a DNA sequence is called a **mutation**. Mutations happen naturally at a low rate, and some chemicals and UV radiation can increase the rate of mutation. Most mutations are not favourable because they mean that the altered DNA code no longer produces what the cell or the organism needs to survive. Many mutations are neutral, that is, they have no effect on the survival of the organism. Very occasionally, a mutation may arise that gives the individual an advantage, and in this case the mutation will be favoured by **natural selection**.

This **variation** between individuals is the basis on which evolution acts.



DNA controls the production of proteins that, in turn, determine many of an organism's characteristics.

Gene duplication

Sometimes a mutation occurs that results in an organism gaining two copies of a particular gene. Since one copy of the original gene can keep on fulfilling the original function, the other may evolve a different role. The Douc Langur is



By gene duplication the Douc Langur has gained an extra enzyme that makes it better adapted to digest leaves than most other monkey species.

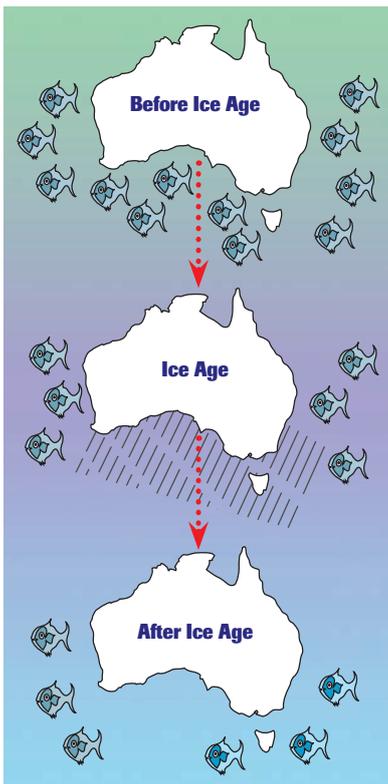
a colobus monkey which eats leaves, instead of fruits and insects, like most other monkeys. Most monkeys have only one kind of a particular pancreatic enzyme called RNASE I, but Douc Langurs have a second kind, RNASE IB, which improves their digestion of leaves.

Speciation

Before the last Ice Age, an ancestral species of wrasse (a fish) lived in the southern coastal waters of Australia. As the Ice Age began, the water temperatures fell and the fish had to move north to survive. The wrasse population was forced to split in two, as some fish moved north along the east coast of Australia, and some moved up the west coast.

Thousands of years passed, and each population continued to accumulate small genetic changes due to mutation and selection. Today's wrasse species, the Eastern Blue Groper and the Western Blue Groper, are very similar fish, but they cannot interbreed because of the accumulation of genetic differences. This is called **reproductive isolation**.

Mutation	→	no effect on organism (neutral)	→	not selected for
Mutation	→	makes organisms fitter (favourable)	→	selected for
Mutation	→	makes organisms less fit (unfavourable)	→	selected against



Reproductive isolation has occurred in these fish because of the cooling of southern waters. This isolation has resulted in genetic differences within the species.

The Eastern and Northern Rosella, and the eastern grey and western grey kangaroos are two further examples of **speciation**.

Speciation (the formation of new species) occurs when a population is divided in some way, genetic change occurs over time, and the two new populations no longer interbreed. Often it is a geographical barrier such as a river, mountain range or desert which divides a population, but there are also some non-geographic means. For example, if one group of animals within a population gradually evolve a different mating season, eventually a separate species could evolve even though the population is still in one geographical area.

Sometimes reproductive isolation can occur by a single large-scale genetic change, producing a separate species in one generation. For example, new species of wheat have occurred when a new strain has a change in the number of chromosomes (DNA and protein structures containing genes), and is unable to cross with either of the parent strains.



The Eastern Rosella (*Platyercus eximius*) (RIGHT) and the Northern Rosella (*Platyercus venustus*) appear to be closely related. They are similar in looks, behaviour and habitat. The Eastern Rosella is found in south-eastern Australia and the Northern Rosella is found in Australia's Top End.

Activities

REMEMBER

- 1 What is a *mutation*?
- 2 Complete the following: _____, the evolution of a new species, often happens when one part of a population is _____ from the rest. Over generations, genetic changes accumulate due to _____ and _____. If after thousands of generations the two populations are brought in to contact and they can no longer interbreed, they are described as _____.
- 3 What does the Douc Langur have that other monkeys lack? How is this believed to have come about?

THINK

- 4 Alfred Wallace observed that the area a species occurred in was often bounded by a river or a mountain range, and different species were present on the other side of the obstacle. Explain this observation in terms of how speciation is thought to occur.

- 5 What kinds of geographical barriers might have led to an ancestral population of rosellas being split into eastern and 'Top End' populations? (*Hint*: Think about a map of Australia and the features that occur between the east and the north.)

DEBATE

- 6 'Mutation is good for a species.' Form two teams and put together the arguments for and against this statement.

RESEARCH

- 7 Australia has many unique species, and in particular, many marsupials. Investigate the relationship between the evolution of Australian animals and the separation of Australia from other continents millions of years ago.



I CAN:

- recall how a mutation occurs in a species
- understand how different subspecies may not be able to interbreed because of reproductive isolation
- understand how speciation occurs during the division of one species.