STUDY GUIDE

TED'S EVOLUTION

SYNOPSIS

Charles Darwin started a revolution when he published his evolutionary theory in the mid 1800s, challenging the belief that God created all creatures in their current form. Since then, Darwinian theory has become the accepted scientific doctrine but now an Australian scientist, Ted Steele, is stirring things up again.

For years, Ted and his collaborators around the world have been researching ideas that challenge a fundamental principle of biology - the Weismann Barrier - and give new meaning to one of the most discredited theories in the history of science. Their proposition is based on the work of Jean Baptiste de Lamarck, published some 50 years before Darwin's *The Origin of Species*. The concept is that characteristics acquired during a lifetime could be passed on to the next generation. Ted is convinced that we can pass on these genetic improvements, such as stronger immunity, to our children.

Encouraged by the great science philosopher Karl Popper, Ted launched his first book in 1979. It challenged the foundations of evolutionary thinking. Since then, he and his collaborators have battled with the scientific establishment, their own universities and the media to have their research accepted.

Has Ted devoted a lifetime to pursuing a false dream or is he about to change what we know about life on earth? *Ted's Evolution* documents the process of a potential paradigm shift. The stakes are high - reputations, careers and our understanding of evolution are all on the line.

CURRICULUM LINKS

The programme is an extremely useful resource for teachers and students studying evolution because it exposes one of the many misconceptions about this subject. Most people believe that evolutionary science is almost complete; the truth is that while the theory of evolution is widely accepted, the exact process by which it proceeds is still a matter for debate.

This study guide has been created for teachers and students from middle to senior years studying Science, particularly Levels 5 to 8.

The follow-up activities are designed around the following strands within the national curriculum framework:

Life and Living - Biodiversity, Change and Continuity
Level 5.9 identifies features of groups of living things that enable them to compete successfully in their environments.
Level 6.9 describes how genetic continuity is maintained from generation to generation.

Level 7.9 outlines evidence of a scientific theory of evolution.

Earth and Beyond - The Changing Earth
Level 6.2 prepares evidence to support current theories on the formation and geological history of the Earth.
Level 8.3 identifies and explains indirect measurements used to support scientific theories of the structure of the Earth.

Earth and Beyond – Our Place in Space
Level 6.3 identifies the stage our sun is at in its evolution and predicts the future of life on Earth.

Working Scientifically: Using Science
Level 6.17 reports on factors that have either made possible or limited the work of particular scientists.
Level 7.17 analyses the influence certain scientists have had on the ways we think about the world.
Level 8.17 analyses the interactions between scientific developments and the beliefs and values of society.

BEFORE WATCHING

EVOLUTION IN HISTORY

In the 19th century a theory of evolution was an idea whose time had come. In the years before Charles Darwin wrote *The Origin of Species,* various scientists had advanced their own versions of evolution. Among them were Erasmus Darwin (Charles' grandfather), Georges Cuvier, Jean Baptiste de Lamarck, Etienne Geoffroy Saint-Hillaire and Alfred Russell Wallace.

Charles Darwin didn't discover evolution, although he was the first person to put forward a convincing theory to explain how the process operated.

Alongside Darwin, Lamarck was the scientist who had a great impact on evolutionary thought, through his later discredited theory of the inheritance of acquired characteristics.

LAMARCK

In 1809 Jean Baptiste de Lamarck proposed the theory that evolutionary change could occur by the inheritance of acquired characteristics. Broadly speaking, this means that the environment encountered by an organism throughout its life can alter that organism and these changes can be passed down to the organism's offspring. For example, a giraffe may have been born with a long neck because its parents spent their lives stretching for leaves on high branches and so stretched their necks.

While Darwin was generally a Lamarckian, this could be ascribed to the fact that no better alternative mechanism for natural selection existed until the work of Mendel was rediscovered in 1900.

DARWIN

English naturalist Charles Darwin published his book *The Origin of Species by Means of Natural Selection* in 1859. In this book Darwin presented compelling evidence to suggest that evolution has occurred among animal and plant species by means of natural selection.

Darwin's theory was based on a number of simple observations:

I. individual members of a species show variation
II. more young are normally produced than are needed to replace their parents
III. populations cannot expand forever and they are limited by food and space
IV. limiting factors cause competition among individuals
V. therefore the best-adapted (fittest) organisms will survive this competition

Over time, as environmental conditions change, this process of natural selection gives rise to different variations and eventually new species.

MENDEL

Gregor Mendel was an Austrian monk who carried out exhaustive experiments on breeding pea plants. In 1866 he had a paper published (to little notice) in which he set out his two laws of heredity:

I. Segregation - the two members of a gene pair separate during sex cell formation.
II. Independent Assortment - different segregating gene pairs behave independently. This applies to unlinked or distantly linked genes.

Mendel's work was rediscovered in 1900.

MODERN SYNTHESIS (neo-Darwinism)

When Darwinian evolution is combined with Mendelian genetics they form a more comprehensive evolutionary theory than either offers alone. This is called neo-Darwinism or the Modern Synthesis.

Mendel identified the source of the variation—genes—that drive Darwinian evolution.

ISSUES IN EVOLUTIONARY SCIENCE TODAY

Within evolutionary science today, scientists are broadly divided into two camps: those who believe in gradualism and those who think that evolution is a more

erratic process—punctuated equilibrium. Many think that either process may occur in certain circumstances.

Gradualists take the position that evolution is a process of accumulated small changes, which lead to a gradual formation of different species and groups of organisms. The majority of evolutionary scientists are gradualists, British ethologist Richard Dawkins being a good example.

Those who follow the punctuated equilibrium school believe that evolution proceeds primarily periodically. Most species are static for large parts of their existence, with evolutionary change taking place over geologically short time spans. These changes can be triggered by things like mass extinction events, such as the asteroid impact that wiped out the dinosaurs 65 million years ago, that subsequently lead to the explosion in mammal species. Stephen Jay Gould and Niles Eldridge advanced the theory of punctuated equilibrium.

These two groups have in common the view that evolution is caused by natural selection operating on essentially random variation which arises spontaneously. As Steven Jay Gould has written:

'Life is a copiously branching bush, continually pruned by the grim reaper of extinction, not a ladder of predictable progress.'[1]

Ted Steele's ideas are compatible with this view, but they differ from those of most biologists because Steele proposes that changes need not arise at random, although natural selection may still be exerted on these changes in later generations. The evidence Ted has found indicates that changes arise in the body's immune system in response to the environment, and are then passed on to succeeding generations.

More extreme views have been advanced by a group known as neo-Lamarckists. These scientists maintained that numerous traits could be affected by conscious efforts to change them, with the changes then passed on to later generations. This group has been largely discredited by its failure to produce experimental evidence for such changes.

THE "WEISSMAN BARRIER"

Lamarckism, and Ted Steele's theories, appear to violate the principle that hereditary information moves only from genes to body cells and not vice versa. This concept is often referred to as the Weissman Barrier after the 19th century biologist August Weissman, who proposed the existence of the germ line, cells that remain unchanged as a repository of the instructions that form a complete organism, and from which the sperm and ova are formed. At the time Weissman did his work, genetics did not exist as a science (Mendel's discovery had been temporarily overlooked), but for the past century it has been widely accepted that changes to genes within body cells are not transferred to the germ line. Without such transfer, Lamarck's model of evolution could not work. Ted Steele has sought, and perhaps found, evidence that just such a transfer has taken place.

One of the challenges presented by his ideas is to understand how such a transfer might take place.

EPIGENETIC EFFECTS

Another way in which the environment might affect genes in the germ line is through epigenetic changes. Epigenetics is the study of changes in genetic expression that are not connected to changes in DNA sequences.

Epigenetic effects operate in two main forms:

1. Methyl ($-CH_3$) groups can be added to certain bases (cytosine) in the DNA molecule.
2. DNA is found wrapped around proteins called histones; these proteins can be altered in a number of ways, including methylation.

Some of these epigenetic effects can be passed on to offspring in ways that may be contradictory to Mendelian genetics.

The effects of epigenetic alterations can be seen in a number of different examples.

> Females have two copies of the X chromosome and its genes, while males have one X and one Y chromosome. To prevent twice as much expression from X-linked genes in females, one entire X chromosome is epigenetically silenced during the early development of the female embryo and then maintained in a silent state for the rest of the life of the female.[2]

Some scientists think that because epigenetics can stably alter the gene expression of an entire cell, these effects may have been crucial for the evolution of eukaryotic life.

Epigenetic mutations may occur because of environmental stress; it is thought that cancer may well result from environmentally induced epigenetic effects.

AFTER WATCHING

QUESTIONS

1. Design an experiment or set of observations that can test Lamarck's theory. For how long would you have to carry out this experiment before you could draw a conclusion? NB. This is a purely theoretical exercise.

2. Picture a herbivore living in an arctic environment where its primary food source is grass roots. Imagine and describe its evolution according to:
a) Lamarckian evolutionary principles.
b) Darwinian evolutionary principles.
How would the herbivore's body (and behaviour) change if the climate became hotter and the grass had to grow longer in order to get more water?

3. Given that Steele's theories only appear to apply to the immune system, does this necessarily invalidate neo-Darwinism? Explain your answer.

4. As female animals are born with all their sex cells intact, and male sex cells are produced and re-absorbed constantly, do you think it is likely that Lamarckian evolution proceeds primarily through the male line? Explain your answer.

5. In the documentary, physicist Ken Augustyn claims that biologists tend to think of the world as a 'total machine and everything is totally predetermined'.
Is this statement true of: a) Lamarckian evolution?
b) Darwinian evolution?
c) Any biological process involving whole organisms?
Make sure you fully explain your answers.

ACTIVITIES

A. Chalk evolution
1. Get about 10 pieces of chalk - of different colours - red, yellow, white, blue and green. Let the students see you break them into smaller pieces.
2. Explain to the students they will be heading to the lawn and will work in groups to find chalk (one piece at a time) and record their findings.
3. Get the students into groups of about 4 or 5. Get them to select a recorder for each group. The recorder will have a sheet of paper that will record the chalk colour and time found.
4. Students go to the edge of the lawn and are then asked to face away from it as the chalk is thrown out randomly over the lawn.
5. All non-recording students are then asked to find the chalk - one piece at a time - and bring it back to the recorder.
6. The last step is back to the classroom. Write - red, yellow, white, blue and green across the top of the board. Ask the student recorder from one group to say which colour was the first found, and the order in which the chalk was found and mark this information on the board.

It will be there for all to see as the results go up. Reds and yellows are found before blues and greens. This pattern of results should be repeated by each group.

Explain to the students that they were birds and the pieces of chalk were worms. Over generations only the green ones would survive - **evolution**.

B. Evolve your own animal
1. Cut out a variety of cardboard animal body parts, different shaped heads, legs, etc.
2. Set extreme conditions for an ecosystem e.g. flooded for six months a year.
3. Get your class to work in groups to design an animal from the cardboard pieces that can survive in the ecosystem that you described.
4. Each group then makes a presentation on their animal and how its body shape allows it to survive in the ecosystem.

5. The ecosystem conditions and cardboard body shapes can be changed as often as is required.

C. Evolution with lollies
1. Divide your students into groups of 3 or 4.
2. Give each group either a set of teaspoons or a set of forks.
3. Each group will then be given a plate with a random assortment of smarties and jelly snakes.
4. Over a period of about five minutes the students will see how many of each type of lolly they can collect from their plate with their given implements.

This activity is designed to show that different predators have evolved different feeding strategies and, in some cases, specialist feeding apparatus to cope with varied food sources.

RESOURCES FOR TEACHERS

WEB SITES

Edward J Steele - Research Site
https://www.researchgate.net/profile/Edward_Steele

PBS site, with an overview of evolution and teacher resources
www.pbs.org/wgbh/evolution

Natural History Museum, London
www.nhm.ac.uk

Human Prehistory – An Exhibition
http://www1.biologie.uni-hamburg.de/b-online/library/darwin/prehis.htm

TED STEELE - SOME REPRESENTATIVE PUBLICATIONS

Steele, E.J. and Blanden R.V. (2001) *The Reverse Transcriptase Model of Somatic Hypermutation – Philosophical Transactions of the Royal Society.* Biological Sciences 356:61-66.

Steele, E. J. (2000) *The Evidence for Lamarck* in *Quadrant* March 2000 No. 364 Vol XLIV Number 3 pages 47-56. © Quadrant and E.J. Steele.

Steele, E.J., Lindley, R. A. and Blanden, R. V. (1998) *Lamarck's Signature: How Retrogenes Are Changing Darwin's Natural Selection Paradigm,* Allen & Unwin, Sydney, 1998; Perseus Books, Reading, MT, USA.

Steele, E.J. and J.W. Pollard (1987) Hypothesis: Somatic Hypermutation by gene conversion via the error prone DNA-to-RNA-to-DNA information loop. *Molec. Immunol.* 24: 667-673.

Steele, E.J. (1979) *Somatic Selection and Adaptive Evolution: On the Inheritance of Acquired Characters*. First Edition. Williams-Wallace, Toronto, 1979: 2nd Edition. Revised with an author's postscript, University of Chicago Press, Chicago, 1981.

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Michael Allanby, *The Concise Oxford Dictionary of Zoology*, Oxford University Press, Oxford, 1992.
Charles Darwin, *The Origin of Species*, Penguin, London, 1968.
Richard Dawkins, *The Selfish Gene*, Oxford University Press, Oxford, 1989.
Richard Dawkins, *The Blind Watchmaker*, Penguin, London, 1991.
Carl Zimmer, *Evolution, The Triumph of an Idea*, HarperCollins, New York, 2001.

ENDNOTES

[1] Stephen Jay Gould, *Bully for Brontosaurus*, Penguin, London, 1991, p. 315.
[2] Vardhman Rakyan, 'A Kink in the Tail of Heredity' in Australasian Science, March 2003, Vol. 24, Number 2, pp 34-35.

Ted's Evolution
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