DARWIN
INSPIRED
LEARNING

Enquire with Darwin

KS3

Module 2: Artificial Selection

Lesson plan

Amassing evidence

An idea central to Darwin's theory of evolution was that species could change over time. The accepted Victorian view was that all species had been created by God and had always existed in their current form.

Darwin amassed a huge amount of evidence to support his idea, and a significant line of evidence came from his observations and work with domesticated animals and plants. Darwin saw artificial selection of useful characteristics by breeders as analogous to natural selection. Here, the ideas of species change and selection are introduced with examples animals and plants with which Darwin worked.

Quotation

'Although man does not cause variability and cannot even prevent it, he can select, preserve, and accumulate the variations given to him by the hand of nature in any way which he chooses; and thus he can certainly produce a great result.'

Charles Darwin, *The variation of animals and plants under domestication*, 1868

Above: An apple variety called Blenheim orange.

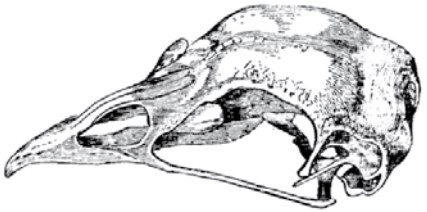
Below: Many varieties of cabbage.

Lesson outcomes

- Recognising that species are not fixed but are capable of change over time.
- Explaining that individual organisms vary.
- Finding evidence for the idea that traits can be selected by human breeders.
- Discussing the idea that selective breeding produces features that are useful to the breeder but not necessarily useful to the organism.
- Comparing and contrasting the processes of natural and artificial selection.
- Identifying how wild animals are adapted to their environment in ways that help them survive and breed.

Curriculum links

- Modern science has its roots in many different societies and cultures, and draws on a variety of valid approaches to scientific practice.
- Use of scientific ideas and models to explain phenomena and developing them creatively to generate and test theories.
- Critical analysis and evaluation of evidence from observations and experiments.
- Obtaining, recording and analysing data from a wide range of primary and secondary sources, including ICT sources. Using findings to provide evidence to underpin scientific explanations.
- Evaluation of scientific evidence and working methods.
- Use of appropriate ICT to communicate scientific information and contribute to presentations and discussions about scientific issues.



Above: Feral pigeons.
Below: Pigeon skulls.

Key words

Variation, variety, artificial selection, selective breeding, adaptation, natural selection, inheritance, species.

Resources

Darwin notebooks and pencils, digital cameras.

Lesson sequence

Pre-visit lesson

Starter activity

Beginning with PowerPoint slide 2, students will see images of domesticated animals and plants. They work in small mixed ability groups (3-4 students) and discuss what the organisms are and what they could have in common. Show slide 3, Darwin's quotation on artificial selection. Support through questioning enables all students to make notes on the links between Darwin's idea and selective breeding.

Main activity

Students are introduced to the concept of variation and, using slides 4 to 7, to Darwin's studies of variation and selection in domestic animals and plants.

Darwin pointed out that all animals and plants show variation. He proposed that breeders select the variants they think desirable. Students play the Rabbit top trumps game following normal rules. The activity can then be followed up in 3 different ways to allow differentiation by ability. (Slides 11-14 may be helpful.)

1. Students design their own table to display the data on the cards.

2. Students produce bar graphs comparing rabbit weight and/or body length and breed. Further differentiation can be provided by asking students to decide which type of graph to use and to justify their choice. The data can be organised in a range of ways depending on the degree of scaffolding required. Examples: data can be sorted by breed before producing the graphs (wild v. domesticated) or students can produce average values for weight/ body length. Everyone can be asked to interpret their data, for example, to discuss the reasons for any differences between rabbit types. Students should be encouraged to consider why the domestic rabbits are larger. (They may have been bred for food. /They don't need to escape predators). Reflect too on how wild rabbit traits help them to survive in the wild (speed, agility, keen hearing).

Above: Freisian cattle.
Below: Wild rabbits.

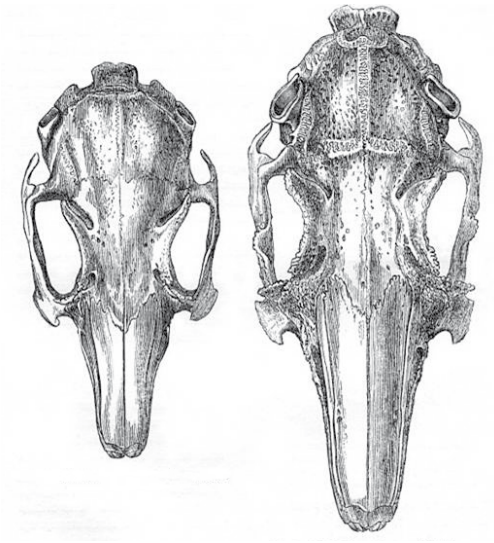
Pre-visit lesson

3. Students examine the relationships between the variables and explore the concepts of cause and correlation. They plot 2 sets of parameters on a scatter graph, either a) rabbit body weight and length or b) skull length and skull volume. Then ask the students if they observe a relationship between the two parameters and whether they can suggest an explanation. They go on to compare another set of parameters of their choice. Finally, ask students to generate a hypothesis based on their analysis. The data supports the idea that artificial selection has altered the size of the rabbits, they are larger generally and heavier, but their skull volume has not increased proportionally. The skulls of the domesticated rabbits are smaller, in relation to their body size, compared with the skulls of the wild rabbits.

Following the Top trumps activity, as a class, students discuss how a trait needs to be heritable to be useful in selective breeding. They choose traits in dogs (slide 9) that could be selected by human breeders and why they might select for those traits.

Plenary

In their Darwin notebooks, students summarise what they have learnt about selective breeding changing species. The whole class discusses: Has selective breeding resulted in improvement? Students provide evidence for any claims they make. Remind everyone to look for more evidence to support their ideas during the visit.



Left: Wild rabbit skull.

Right: Large lop-eared rabbit skull (same relative size).

Extension activities

Differentiation:

- The Top trumps activity can be differentiated as described above.
- Using slide 9 and the websites suggested, students explore the ethical issues associated with selective breeding. They can summarise the news coverage of the Royal Society for the Prevention of Cruelty to Animals (RSPCA) criticism of the Kennel Club, and present both sides of the argument.

http://www.independent.co.uk/life-style/house-and-home/pets/features/crisis-in-the-kennel-is-crufts-cruel-932929.html

http://www.dailymail.co.uk/news/article-1094182/BBC-drops-Crufts-40-years-Kennel-Club-refuses-cruel-dog-breeding.html

Visit

A farm, city farm, rare breeds centre, a natural history museum (for example, Tring Museum has collections of domestic animals), animal sanctuary, garden centre with a pet section.

Students take notes on the traits they see in specific domesticated animals. They ask questions and look for a range of evidence to identify the origins of animals that have been domesticated. They use digital cameras to record their evidence.

Post-visit lesson

Starter activity

Students watch footage of rabbits in the wild http://www.arkive.org/rabbit/oryctolagus-cuniculus/video-11.html. In groups, they discuss how rabbits are adapted to avoid predators. They compare the wild rabbit with pet lop-eared rabbits (slide 10) and discuss how selective breeding has made the pet rabbit less able to avoid predators.

Above: German Shepherd dog

Below: Miniature Lop-eared rabbit.

Post-visit lesson

Main activity

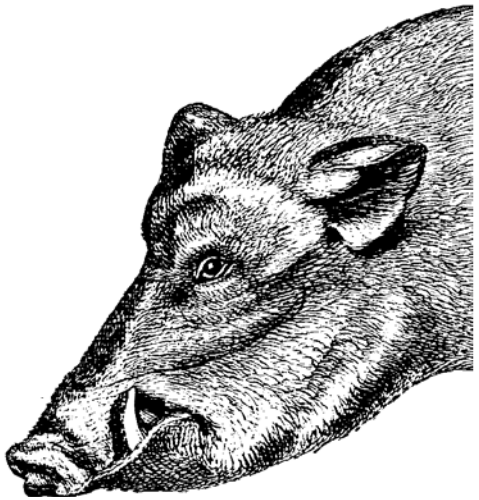
Students choose an animal they saw on their visit and investigate further its characteristics and the characteristics of its wild counterpart. They need to find out:

- how the animal has changed
- why this feature was selected by human breeders, how it is useful to humans, why humans wanted to domesticate the organism
- when and where humans started breeding the animal
- what adaptations the wild animal has to survive in its natural habitat
- how the changes brought about by selective breeding make its domestic counterpart unlikely to survive in the wild.

To differentiate this activity for lower ability students, teachers can allocate particular animals for them to research and provide stimulus material. Good sources are: http://www.exploringnature.org/db/detail_index.php?dbID=6&dbType=2t (also see websites and references).

Plenary

In groups, students present a poster session, make a presentation or write a report which includes their evidence and reference sources. Each member has to present part of their group's research.



Wild boar.

Assessment of progression

AF1 and AF5

The Top trumps activity allows assessment through data presentation and interpretation.

Notes for teachers

Pre-visit lesson

Starter activity

In Darwin's time, the concepts of variation and selection were not a recognised part of biological theory as they are today. The people of Victorian Britain, including many in the scientific community, believed in the Biblical account of creation which was not compatible with the idea that species had been modified by selection over time.

Today we take for granted that there is huge variation in the natural world. PowerPoint slide 2 shows examples of (top line) apples, cattle, chickens; (bottom line) peas, rice, sheep. Some animals are bigger than others, some faster, some plants grow taller than others, and some produce more fruit. Slide 4 shows this variation for one apple variety. Variation is particularly obvious in humans, where members of the same family can differ greatly one from another. Without variation, an organism cannot have an advantage over others, and selection cannot occur. Darwin was the first scientist to understand this fully, appreciate its significance, accumulate evidence from many sources, and publish his ideas.

Darwin knew his theory of evolution by natural selection was controversial and would not be accepted easily by Victorian society. Darwin understood that he would need to accumulate a number of lines of evidence to support his ideas. His microscopic study of variation in barnacles was part of this process, but he recognised that selective breeding (artificial selection) was a powerful model for natural selection, easy for people to relate to and easily replicated evidence of species change even for non-scientist.

Slides 5 and 6 shows that Darwin realised that people noticed this variation and used it to change some animals and plants over time. For example, some chickens lay lots of eggs, others lay fewer. People were using selective breeding to increase the number of eggs their chickens laid. These chickens shown in slide 5 are all a bit different. Ask students which chicken they want to breed more of? (This depends on whether they are for eggs or meat.)

Above: Supermarket apple varieties.

Below: A domesticated chicken.

Pre-visit lesson

Slide 6 indicated that the outcome of selective breeding over many generations produces a population that all have a specific trait. For instance, if you breed only from hens that are good layers, eventually all your hens could be good layers. Over a long period, the number of eggs laid can be greater, although there are limits!

Darwin studied many domesticated animals from farm animals to pets such as dogs, cats and rabbits and many cultivated vegetables, fruits and ornamental plants. He devoted much of his time to the fancy pigeon, cataloguing the details of all the breeds and comparing them with their wild counterpart. He worked on pigeons because of the enormous variety they displayed. Almost every external physical feature had been changed, creating birds with different beaks, feet, plumage, tails, body size, head size and shape, feather colour, cooing sound and flying behaviour. Fancy pigeon breeding was a popular hobby in the mid-19th century, and Darwin consulted and corresponded with breeders from all over the world to amass evidence of variation and to develop an argument for species change by selective breeding. Darwin's hypothesis was that all fancy pigeons were actually descendents of the wild rock dove, and their strange features had been selected by breeders.

The Top trumps game makes use of Darwin's data and is available to print and laminate.

Rabbits are herbivores and therefore primary consumers with a number of predators. They have developed adaptations to reduce predation. For example, they are light, agile, fast and have large, positionable ears, strong back legs and are able to sit up on their back legs to look out for predators. They have a good sense of smell and live in groups, the advantage being that all are alert to danger.

Fantail pigeon, a variety of rock dove, and a feral pigeon.

Plenary

Keep all notes and questions in students' Darwin notebooks and take them on the visit.

Visit

A risk assessment will be necessary and a preliminary visit is advisable. The visit can be held at any time of the year but farms may be closed to visitors in winter months. Meeting an expert in animal breeding at the venue would make this visit more powerful. Ask students to keep notes about the animals they see and to take photographs (a potential resource for the post-visit plenary). The visit is intended as a time to gather evidence of artificial selection. The pre-visit lesson introduces Darwin's idea that species are not fixed but can be changed by selection, and on the visit students are looking for evidence that selective breeding may not change the organism for the better. For instance, selectively bred animals might not adapt to living in the wild if they escaped. A Q&A session with an expert would be helpful.

Farming chickens for meat.

Post-visit lesson

Use of ICT will enable students to research their organisms on line. They need individually to provide evidence of their research findings. The current human exploitation of a specific characteristic may be included, for example, enhanced egg production. Students can combine their findings in a written group report, a group poster or a class presentation. They must include their source references.

Plenary

The students present their findings and answer questions.

Assessment of progression

The data analysis activity in the pre-visit lesson allows differentiated assessment. The post-visit research activity could include an assessed presentation or peer assessment of the research each group carried out.

Website links, videos Interactives, references

Footage of wild rabbits

http://www.arkive.org/rabbit/oryctolagus-cuniculus/video-11.html

Food

www.historyworld.net/wrldhis/PlainTextHistories.asp?historyid=ab57

http://archaeology.about.com/od/domestications/Domestications_of_Animals_and_Plants.htm

Darwin's work on selective breeding

http://www.christs.cam.ac.uk/darwin200/pages/index.php?page_id=d2

Resource materials

Darwin's rabbit data

Name Of Breed	I.	II.	III.		IV.	V.	VI.	VII.		
	Length of Skull.	Length of Body from Incisors to Anus,	Weight of whole Body.		Capacity of Skull measured by Small Shot.	Capacity calculated according to Length of Skull relatively to that of No.1.	Difference between actual and calculated capacities of Skulls.	Showing how much per cent. the Brain, by calculation, according to the length of the Skull, is too light or too heavy, relatively to the Brain of the Wild Rabbit No.1.		
Wild and Semi Wild Rabbits	**inches.**	**inches.**	**lbs.**	**ozs.**	**grains.**	**grains.**	**grains.**			
1. Wild rabbit, Kent	3.15	17.4	3	5	972	• •	• •			
2. Wild rabbit, Shetlands Islands	3.15	• •	• •		979	• •	• •			
3. Wild rabbit, Ireland	3.15	• •	• •		992	• •	• •	[2 % too heavy in comparison with No.1]		
4. Domestic rabbit, run wild, Sandon	3.15	18.5	• •		977					
5. Wild, common variety, small specimen, Kent	2.96	17.0	2	14	975	913	38	4	per cent.	too light.
6. Wild, fawn variety, Scotland	3.1	• •	• •		918	950	32	3	"	"
7. Silver-grey, small specimen, Thetford warren	2.95	15.5	2	11	938	910	28	3	"	too heavy
8. Feral rabbit, Porto Santo	2.83	• •	• •		893	873	20	2	"	"
9. Feral rabbit, Porto Santo	2.85	• •	• •		756	879	123	16	"	too light
10. Feral rabbit, Porto Santo	2.95	• •	• •		835	910	75	9	"	"
Average of the three Porto Santo rabbits	2.88	• •	• •		828	888	60	7	"	"
Domestic Rabbits	**inches.**	**inches.**	**lbs.**	**ozs.**	**grains.**	**grains.**	**grains.**			
11. Himalayan	3.5	20.5	• •		963	1080	117	12	"	"
12. Moscow	3.25	17.0	3	8	803	1002	199	24	"	"
13. Angora	3.5	19.5	3	1	697	1080	383	54	"	"
14. Chinchilla	3.65	22.0	• •		995	1126	131	13	"	"
15. Large lop-eared	4.1	24.5	7	0	1065	1265	200	18	"	"
16. Large lop-eared	4.1	25.0	7	13	1153	1265	112	9	"	"
17. Large lop-eared	4.07	• •	• •		1037	1255	218	21	"	"
18. Large lop-eared	4.1	25.0	7	4	1208	1265	57	4	"	"
19. Large lop-eared	4.3	• •	• •		1232	1326	94	7	"	"
20. Large lop-eared	4.25	• •	• •		1124	1311	187	16	"	"
21. Large hare-coloured	3.86	24.0	6	14	1131	1191	60	5	"	"
22. Average of above seven large lop-eared rabbits	4.11	24.62	7	4	1136	1268	132	11	"	"
23. Hare (*L.timidus*) English Specimen	3.61		7	0	1315					
24. Hare (*L.timidus*) German Specimen	3.82		7	0	1455					

Key

•• - no data available

CHARLES DARWIN TRUST

Acknowledgements

This resource has been produced by The Charles Darwin Trust

Series editor Dr Susan Johnson

Author Emma Newall

Editor Karen Goldie-Morrison

Design SPY Studio

Photographs taken at Down House are with thanks to English Heritage which owns and opens the House to the public.

Thank you to our current funders who are supporting Darwin Inspired learning and have made *Enquire with Darwin* possible: the Evolution Education Trust, the Foyle Foundation, the Garfield Weston Foundation, the JJ Charitable Trust and the Mark Leonard Trust, The Mercers' Company, and a number of individual donors.

Picture Credits

Front page mercedesfromtheeighties/Wikimedia

Page 1 Dr Susan Johnson

Page 2 above Dr Susan Johnson

Page 2 below Project Gutenberg

Page 3 above Dr Susan Johnson

Page 3 below Worm that Turned/Wikimedia

Page 4 Project Gutenberg

Page 5 above Akse107/Wikimedia

Page 5 below Miniaturlop/Wikimedia

Page 6 Project Gutenberg

Page 7 above Wikimedia

Page 7 below Dr Susan Johnson

Page 8 above Dr Susan Johnson

Page 9 Wikimedia