Teachers' Notes: Science Worksheets
Selective Breeding of Farm Animals; Food Chains and Farm Animals

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Selective breeding and food chains worksheets

The *Selective Breeding of Farm Animals* worksheet explains the basic process using chickens as an example. The worksheet also reinforces other biological concepts including genetic and environmental causes of variation, mutations and natural selection.

The *Food Chains and Farm Animals* worksheet discusses energy losses in human food chains and pyramids of numbers.

Both worksheets raise ethical issues relating to science and technology and encourage students to formulate their own opinions, especially in relation to the different ways we use animals in producing food.

Selective breeding worksheet – suggested lesson plan:

1. Introduction. Explain an example of selective breeding, eg wheat plants have been selectively bred for yield, protein content, resistance to disease, flavour, to be good for making biscuits etc. Discuss the advantages of some of these. *(2-3 minutes)*

2. Discuss (small groups, then whole class) what chickens might be selected for (meat, fast growth, more breast meat, eggs, higher egg production, colour of eggs, larger or smaller eggs etc). *(5-8 minutes)*

3. Hand out worksheet. Read in silence, but allow discussion when they reach ethical points. *(allow 10 minutes; they are not expected to finish at this stage)*

4. Watch all or part of the video. *(up to 20 minutes; more if you include breaks for discussion)*

5. Discuss.

6. Complete worksheet in lesson or for homework.

Use with *Farm Animals & Us* films. We recommend the first film *Farm Animals & Us* for students aged up to 14 or 15 and the more detailed *Farm Animals & Us 2* for abler and older students.

The DVD-ROM with these films is available free to schools and can be ordered at **ciwf.org/education.** The films can also be viewed online at **ciwf.org/students.**

FARM ANIMALS & US: TEACHING RESOURCES FOR SCHOOLS, COLLEGES & UNIVERSITIES

Crossword solution

Food chains and farm animals worksheet – suggested lesson plan:

Discuss/brainstorm human food chains.
(5 minutes)

Hand out worksheet. Read in silence, but allow discussion when they reach ethical points. *(Allow 10 minutes; they are not expected to finish at this stage)*

Watch all or part of the film. *(Up to 20 minutes; more if you include breaks for discussion)*

Discuss.

Complete worksheet in lesson or for homework.

Variation (especially for groups with low reading ages):

These worksheets have reading ages of 11-12. If your students have lower reading ages than this, we suggest either that they are encouraged to read all or part of it aloud in pairs or small groups, or that it is read aloud in class. It may help understanding in this case if you show and discuss the film before using the worksheet, perhaps in an earlier lesson.

Potatoes ➔ Human

Rice ➔ Human

Grass ➔ Cow ➔ Human

Grass ➔ Sheep ➔ Human

Wheat ➔ Chicken ➔ Human

Corn ➔ Pig ➔ Human

Phytoplankton ➔ Zooplankton ➔ Sand eel ➔ Salmon ➔ Human

Examples of human food chains

Crossword solution

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photo: © Colin Seddon

The chickens on the left are egg-laying hens. They have been **selectively bred** to lay lots of eggs, but they grow at a normal rate. Globally, most laying hens are kept in cages. In Britain, most hens are either free-range or kept in colony cages (see photo above). The chickens on the right are broiler chickens. They have been bred for meat. They grow twice as quickly and are usually slaughtered at six weeks old. Most meat chickens are kept intensively in large sheds.

All of these chickens have the same common ancestor. They are descended from the jungle fowl, which can still be found in the wild in the forests of India and South-East Asia. Chickens were first domesticated at least 3400 years ago.

Farmers have been selectively breeding chickens for thousands of years. The basic method is quite simple. If you breed from the hen which lays the most eggs, the chances are that her daughters will also be good layers. This is because the number of eggs which a hen lays is partly controlled by the genes which a hen inherits from her parents. Meat chickens have been selectively bred using the same principle.

Selective breeding has become a complex scientific business. A wild jungle fowl might lay 20-30 eggs in a year. Today's hens each lay over 300 eggs a year on average.
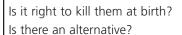
Eggs have become a cheap food, but at a cost to the hen. Even with good food, her bones may be depleted by the calcium she uses to make all those egg shells. Hens often suffer from broken bones, partly due to calcium depletion.

Our demand for cheap food has caused us to make our farm animals work harder. As we shall see over the next two pages, this is not always good for them.

Casualties of selective breeding

Each year, in the UK, over 30 million day-old chicks are killed at birth. These are the males of egg-laying breeds.

Only hens lay eggs. 70 years ago, these male chicks would have been reared for meat. Today, they do not grow fast or meaty enough to produce chicken meat economically.

Is it right to kill them at birth? Is there an alternative?

Egg production and a hen's environment

A chicken's **environment** is also important. It takes energy to make eggs. However they have been bred, chickens won't lay more eggs unless they are given extra food.

Chickens also lay more eggs when the days are longer. This is an old **adaptation** to encourage the hen to lay eggs in summer when there will be more food for her chicks. Nowadays, lights are kept on in chicken houses for part of the night to increase egg production.

Chickens may be kept in cages, in barns or free-range. Intensive production may be slightly cheaper, but free-range environments like the one on the right can be better for the welfare of the birds. How do you think they should be kept?

Selective Breeding of Farm Animals

This broiler chicken cannot stand. His body has grown too fast for his legs. Soon he will be unable to reach food or water.

Many meat chickens go lame. This is a result of selective breeding for meat. The chicken in the picture above has been bred to grow fast. He has been bred to put on a lot of meat. Unfortunately, his joints have not developed as fast as his muscle.

Some scientists believe that a third of meat chickens suffer pain whilst standing. Over 3% have difficulty walking more than a very short distance. Many chickens die of heart problems, since their hearts cannot keep pace with their bodies.

Few animals which have been selectively bred would survive in the wild. This is certainly true of the meat chicken. Broiler chickens which are spared from slaughter often die young.

This is a problem for those who wish to breed broiler chickens. To keep the parent birds healthy, they have to be restricted to a quarter of their normal diet while they are growing. They have been bred to be hungry so they grow fast, but to keep them healthy they have to be kept hungry. Is this fair?

Artificial Selection is another name for selective breeding. In the wild, natural selection weeds out animals which are not adapted to their environment. Artificial selection may be useful to us, but it may produce animals which are more likely to suffer.
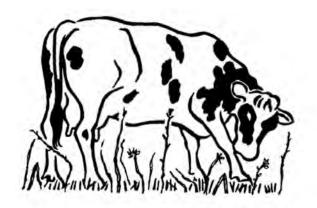
Selective breeding can be used to help to put this problem right. We can breed animals with stronger hearts and legs. Nevertheless, the more we breed animals to be productive, the more they are likely to suffer from the side-effects of working too hard.

This broiler chicken is being kept free-range. You can buy free-range chicken in many supermarkets. They grow more slowly since EU rules require them to live for 56 days (most intensive chickens reach slaughter weight in less than 40 days). Slower growing indoor chickens are also available on the RSPCA Freedom Food label.

You will notice that these chickens cost more but, as they grow more slowly, they have lower levels of lameness. Which do you think is more important – cheap meat or healthier animals who are not in pain?
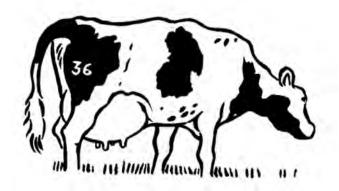
Cows – bred for meat or milk

The cow above has been selectively bred for meat. She produces enough milk to feed one calf. Her calf will milk her six times per day. She only needs a small udder.

The picture below shows a dairy cow. She has been bred for milk. She has been selectively bred to produce enough milk for up to ten calves, but her calf is removed from her shortly after birth. Most cows are only milked twice a day.
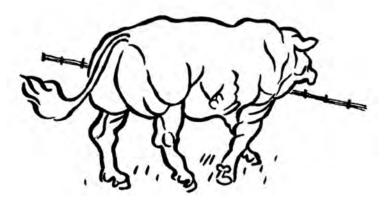

Notice the size of the dairy cow's udder. It may have to carry over 20 litres of milk. Many cows go lame through carrying all this milk.

Producing such a large quantity of milk requires a massive amount of energy. It has been said that the metabolic rate of a dairy cow is equivalent to that of a Tour de France cyclist! This can cause health problems for the cow. Naturally, a cow can live for thirty years, but many dairy cows are in poor health after three or four years of milking and are sent to slaughter because they no longer produce milk economically.

The Belgian Blue

An ancestor of this animal had a mutation. This is a spontaneous change in a gene. The mutant gene caused an effect called "double muscling." The animal's large muscles produce a substantial amount of beef.

Both Natural Selection and Selective Breeding depend on mutations which occasionally produce new characteristics which are helpful. Evolution through Natural Selection wouldn't happen without beneficial mutations.

The double-muscling gene, however, is not beneficial to the Belgian Blue. It causes difficulties when the Belgian Blue cow is giving birth. The extra muscle gets in the way of her cervix, making it smaller. Meanwhile, the extra muscles make the calf larger. Many Belgian Blue calves therefore have to be born during caesarean operations.

Scientists say that genetic engineering techniques could be used to pass the double-muscling gene into other animals like sheep, pigs and chickens.

The Pig

Pigs are descended from the wild boar. Wild boars give birth to litters averaging around five piglets. The modern sow produces 12 piglets at a time. Litters of over 20 have been known.

This can put a strain on the mother. Partly to overcome this, the piglets are removed from their mother at three to four weeks old, much earlier than is natural. This causes stress and health problems for the piglets, but most survive. The mother is able to recover and become pregnant again more quickly. The result is cheaper pork, ham and bacon. It may not be so good for the sow and her piglets.

Selective Breeding of Farm Animals

What do you think? - What do you know?

Test your opinions

Use what you have read, and your own knowledge, to decide what you think about the following examples of selective breeding. Tick those you approve of, put a cross by those you disapprove of, and put a question-mark by those for which you would need more information to decide. More information is available from Compassion in World Farming's Website which you can find via **www.ciwf.org**.

- Selectively breeding hens to lay more eggs ☐
- Selectively breeding wheat plants so that you get a larger crop ☐
- Selectively breeding chickens to grow faster for meat ☐
- Genetically engineering pigs to grow faster ☐
- Selectively breeding a prettier rose ☐
- Selectively breeding a Bulldog with a snub-nose ☐
- Selectively breeding Belgian Blue cattle with double-muscling genes ☐
- Selectively breeding people to be better at Science tests ☐
- Selectively breeding an apple tree to be resistant to pests and diseases ☐
- Selectively breeding pigs to produce larger litters of piglets ☐
- Selectively breeding cows to produce more milk ☐

Test your understanding of the terms used in this worksheet

(hint – words in bold in the text are likely to appear!)

Across

2) (with 5 down) _____ _____ produces animals which grow faster, lay more eggs etc. (9)

6) _____ Selection is where people select the genes of animals or plants which are passed on from one generation to the next (10)

7) Inherited from your parents (4)

8) Genetic _____ transfers genes from one species to another (11)

9) _____ happens as a result of Natural Selection (9)

10) An _____ helps an animal survive or reproduce in its environment (10)

Down

1) A spontaneous change in a gene (8)

3) Your characteristics are controlled by your genes and this (11)

4) _____ Selection controls which genes are passed on from one generation to the next without interference by man. (7)

5) (with 2 across) (8)

Food Chains and Farm Animals
Human food chains and energy efficiency

Humans are at the top of the food chain.

Here is an example:

When we eat toast we are at the top of a very short food chain. We are absorbing energy which a wheat plant originally absorbed from the sun in **photosynthesis**.

If we eat meat, we are at the top of a longer food chain:

When we eat chicken we obtain energy from the chicken which obtained it from the wheat which in turn absorbed it from the sun.

However, we only get a small amount of that energy. This is because energy gets used up at each stage of a food chain (see box below).

You aren't everything that you eat!

You may have heard the term "You are what you eat." Luckily, this is not entirely so!

In a lifetime, the average human will eat several tonnes of food. Happily, no-one gets to weigh that much!

What happens to it all? Firstly we don't digest everything. Half of it ends up going down the toilet. In other words we **egest** it as faeces.
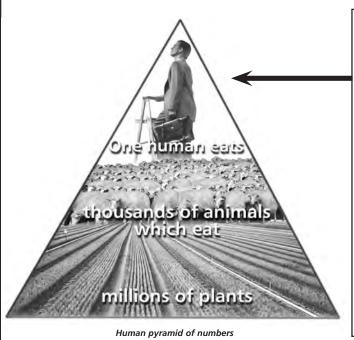
Most of the rest we use for energy, maintaining our bodies, keeping warm, exercising and so on. This food is changed by **respiration** into carbon dioxide and water which we **excrete**, for example by breathing. The **energy** is ultimately lost as **heat**.

Only a tiny proportion is retained in our body as muscle, bones and other tissues.

It is a similar story with animals. Less than 30% of what an animal eats ends up as meat. The rest is disposed of by **excretion** or **egestion**.

If you want to feed as many people as possible, it is therefore more efficient to eat plant foods like cereals, fruit and veggie-burgers than animal foods like meat, milk and eggs.

Meat production can be made more energy efficient by keeping the animals more intensively. However, some people feel this is cruel to animals. In the next two pages we will consider this.

Human pyramid of numbers

The human pyramid of numbers

In your lifetime, if you eat meat, you are likely to consume 1000 chickens, 45 turkeys, 30 sheep, 20 pigs*, 4 beef cattle*, the life's work of 35 laying hens and of one dairy cow. This is over a thousand animals, and each will have consumed hundreds or thousands of plants. Most people also consume thousands of fish. This idea is shown in the diagram of the pyramid of numbers.

People make many choices about their food. For example, you can eat the cheapest meat, pay extra for free-range or organic meat, or you can go vegetarian.

These choices make a difference to the efficiency of food production. They also make a difference to the welfare of a very great number of animals.

Unless for religious reasons you don't eat pork or beef.

Making food chains more efficient - what do you think?

Reducing energy loss

Farm animals, like chickens and pigs, use up a lot of the food they eat. They use it for energy, for exercise, to keep warm and to maintain their bodies. In addition, much food is also wasted in their faeces. This means that only a small amount of their food is turned into meat or eggs. Can we reduce the amount of energy they need?

The animals can be kept warm by crowding them into sheds. They can be prevented from exercising by confining them into cages. If they are bred to grow faster, they can be killed younger and use less energy living and maintaining themselves.

All of this would leave more energy to make meat and eggs. We could produce them more cheaply. However, some people think it is cruel to treat animals like this. Read the examples below, and see what you think. Tick the box underneath each example to express your opinion.

The battery cage

Most British hens used to be kept in barren battery cages, a system widely used in most of the world. The cage prevents exercise and the crowding keeps them warm. This reduces the amount of food they need and helps to keep eggs cheap.

Since the ban on the barren cage in the EU, just over 40% of British hens are now kept in colony cages (see photo), whilst over 50% are kept free-range. Hens in colony cages have a little space to move around in, but the freedom to exercise is very limited compared to free-range systems.

My opinion of the enriched cage

-3	-2	-1	0	+1	+2	+3

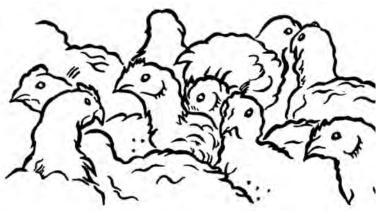Totally unacceptable   Totally acceptable

Selective breeding of broiler chickens

photo: © FAUNA

This broiler chicken has been selectively bred to grow very fast. He will reach slaughter weight in about 6 weeks. This is twice as fast as it is normal for chickens to grow.

Halving the length of chickens' lives means that they will need less energy to maintain themselves, keep warm and exercise. Crowding them into sheds also keeps them warm.

Broiler chickens have been bred to grow so fast that their legs cannot always keep up. This results in difficulty standing or walking. They may also find it difficult to eat or drink. According to one recent piece of research, 27% of chickens suffer serious lameness and over 3% have difficulty walking more than a very short distance.

My opinion of the selective breeding of broiler chickens

-3	-2	-1	0	+1	+2	+3

Totally unacceptable   Totally acceptable

Food Chains and Farm Animals
Can alternatives to intensive farming be efficient?

Vegetarian and vegan diets

Vegetarians don't eat meat or fish. Vegans are vegetarians who don't eat any animal products including milk and eggs.

It takes less land to feed a vegetarian because they live lower down the food chain. Less food energy gets used up by animals. People also go vegetarian because they don't want to kill animals or because they think intensive farming is cruel. Others believe it is a healthier diet, with a lower risk of heart disease and some cancers.

A vegetarian diet can supply all nutritional needs. It is one way of increasing the efficiency of the food chain.

My opinion of vegetarian and vegan diets

| -3 | -2 | -1 | 0 | +1 | +2 | +3 |

Totally unacceptable   Totally acceptable

Free-range and organic meat, milk and eggs

Free-range animals use more energy. They need it for exercise and for keeping warm. If they grow more slowly and live longer, they will use more energy for body maintenance.

Yet people want to buy free-range meat, milk and eggs because they believe this is kinder to animals. They would like animals to have longer lives. They also want to buy organic foods, produced without the use of artificial fertilisers or pesticides, for the sake of the environment.

Can a free-range or organic diet be made efficient? Some people address this problem by eating less meat, whilst making sure that what they do eat is kinder to animals and to the environment.

My opinion of eating free-range and organic meat, milk and eggs

| -3 | -2 | -1 | 0 | +1 | +2 | +3 |

Totally unacceptable   Totally acceptable

Grass-fed meat and milk

Chickens and pigs are normally fed on grains and other crops. It would be more efficient if these were directly fed to people.

Cattle and sheep are grazing animals which eat foods like grass. This means that they can be kept free-range on land that isn't used to grow food crops, eg the Welsh hills. Productivity is not very high, but the animals are eating grass that we wouldn't eat!

(Cattle are usually fed some grain as well – this is not an efficient way of producing meat).

My opinion of eating grass-fed meat and milk

| -3 | -2 | -1 | 0 | +1 | +2 | +3 |

Totally unacceptable   Totally acceptable

Food Chains and Farm Animals
What do you think? - What do you know?

Test your opinions

What do you think about the following? Tick those you approve of, put a cross by those you disapprove of, and put a question-mark by those for which you would need more information to decide. More information is available from Compassion in World Farming's website which you can find via **www.ciwf.org**

- Keeping pregnant sows (pigs) in sow stalls in which they cannot turn around ☐
- Becoming vegetarian ☐
- Selectively breeding cows to produce more milk ☐
- Keeping hens in battery cages ☐
- Eating less meat ☐
- Selectively breeding chickens to grow faster for meat production ☐
- Keeping meat chickens free-range ☐
- Eating grass-fed free-range lamb ☐
- Genetically engineering pigs to grow faster and leaner ☐
- Producing meat organically ☐
- Using fertilisers and pesticides to increase crop production ☐

Sow stall.
This system is illegal in the UK,
but widely used in other countries.

Test your knowledge of food chain terms

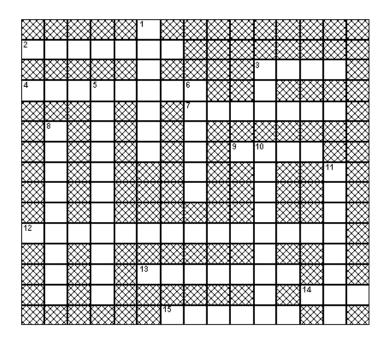*(hint – words in bold in the text are likely to appear!)*

Across

2) _____ chicken - kept in cage (7)
3) If animals are kept _____ they use less energy to generate heat (4)
4) Farm animals use more energy, but are healthier, if they are allowed to do this (8)
7) Pyramid of _____ shows how populations get smaller along a food chain (7)
9) Energy is lost from the food chain in this form (4)
12) Process by which plants make food (14)
13) _____ of biomass shows loss of matter along a food chain (7)
14) Female pig (3)
15) Energy passes along food _____ (6)

Down

1) Chicken kept for meat (7)
3) Inter-connected food chains make up a food _____ (3)
5) Process by which energy is released from food (11)
6) Gradually used up as it passes through a food chain (6)
8) Obtaining oxygen and excreting carbon dioxide (9)
10) Disposal of wastes made in respiration and other body processes (9)
11) Disposal of faeces (8)

Visit **ciwf.org/students** to view films and obtain information about the welfare of farm animals.

BSE - a disease spread by the food chain

Cattle are naturally vegetarian animals. It was found that they could grow more efficiently if they were fed some meat. Beef was included in the feed. When BSE developed, it quickly multiplied in an ever-cycling food chain. More than 170,000 animals became infected, and the disease spread to people. Should meat ever have been fed to a vegetarian animal?