

Genetic Engineering & Farm Animals

introduction

This resource pack consists of a video, poster information sheets and classroom activity worksheets.

The material is suitable for a range of abilities from ages 14 to 18 in English, Science, Biology, Religious Education, Personal & Social Education and General Studies.

The video and notes discuss the welfare implications of the genetic engineering of farm animals and raise ethical issues about the use of these recent developments in biotechnology.

The video begins by looking at the choices facing farming today, asking if we want to maintain the current emphasis on factory farming, adopt the free-range approach or use genetic engineering to create new forms of farm animals. It goes on to discuss the genetic engineering of farm animals by asking:-

- **What is Genetic Engineering?**
- **Is Genetic Engineering Cruel?**
- **Is it necessary?**
- **Is it the future we want?**

The video also questions the claimed benefits of genetically engineered animals, namely that they could :-

- **be more productive**
- **be disease resistant**
- **produce human medicines**
- **produce transplant organs**

The support materials will enable students and teachers to discuss the issues raised in the video and explore the wider welfare and ethical implications of the genetic engineering of farm animals. At the end of the worksheets there is a glossary and a list of organisations which can be contacted for further information.

selective breeding

Selective breeding can produce faster growing chickens, hens which lay more eggs, cows that produce more milk, etc. Farmers have realised for thousands of years that if you cross the chickens which lay the most eggs with cockerels whose mothers laid well, the offspring may well lay many eggs. Repeat this process over many generations and egg laying increases enormously. Our modern understanding of genetics has enabled us to speed up the process of selective breeding considerably.

Up until 10-15 years ago genetic manipulation was achieved by selective breeding. Selective breeding is carried out for the selection of 'traits', rather than for individual genes. Because of this, selective breeding is less likely to produce adverse effects in the animals than is the modification of specific genes, as is done in transgenic research. Even so, selective breeding has resulted in serious welfare problems for farm animals, some of which are detailed here.

broiler chickens

As a result of selective breeding (and rich diets) the modern broiler chicken (broilers are the chickens reared for meat, not eggs) reaches slaughter weight in just 42 days. This is twice as fast as 30 years ago. This fast growth rate means that many broilers are growing too fast for their hearts and lungs. As a result, several million birds suffer heart failure and die each year. (We slaughter 700 million broiler chickens each year in the UK). Many more broilers suffer severe and crippling lameness problems because their huge meaty bodies cannot be supported by their weak skeletons.

turkeys

Like broiler chickens, turkeys have also been bred to develop as much meat (muscle) on their bodies as quickly as possible. The heavy weight of the turkey's body can lead to a lot of pressure on the hip joints and this can result in chronic pain. The shape of body which selective breeding has produced makes it impossible for turkeys to breed naturally. The male birds are too big and heavy to be able to 'mount' the females. As a result, nearly all turkey breeding on factory farms has to take place through artificial insemination.

egg-laying hens

Modern egg-laying hens have been selectively bred to produce around 300 eggs a year and this puts a strain on the hens' calcium reserves. The ancestor of the hen, the jungle fowl of south-east Asia, lays 12 - 24 eggs a year. (Calcium is an important mineral in egg shells and the hens' bones). The hens lose a lot of calcium and, coupled with lack of exercise, this makes their bones very brittle. Up to 70% of hens kept in cages suffer from brittle bones which can easily lead to bone fractures.

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pigs

Selective breeding has been used to develop pigs that grow rapidly and develop heavy muscles (meat). Like broiler chickens, the pigs' legs cannot keep pace with the rapid growth rate of the rest of their bodies. As a result, pigs often suffer from painful joint and leg problems. They also grow so quickly that their hearts and lungs cannot cope, so even young pigs can suffer heart attacks.

cattle

Once again, muscle development has been the goal of selective breeding in beef cattle. The Belgian Blue breed is an example of the problems associated with selective breeding of beef animals. This breed has been bred for 'double muscling' which leads to larger, heavier muscles at the hind quarters. This means that cows carrying these Belgian Blue calves are frequently unable to give birth naturally as the calves are too big. As a result, the cows often endure several caesarean births during their lifetime.

dairy cows

Selective breeding has also been practised on dairy cows, in order to produce animals which give much more milk than their calves would naturally consume. This places the animals under metabolic stress, predisposing them to a range of nutrient deficiencies, and also means that many dairy cows suffer from lameness and mastitis (a highly painful udder disease).

genetic engineering

Farm animal genetic engineering usually involves taking genes from one species of animal and inserting them into a completely different species. Genetic engineering is therefore not the same as selective breeding, where animals of the same species (displaying “desirable” traits) are bred with one another.

What are genes?

Genes are chemical messengers made from a complex chemical called DNA. Genes carry the information about how we look, some of our behaviour patterns and other characteristics. Genes are passed on through generations. You, for example, will have inherited your particular eye or hair colour from your parents or grandparents. Your genes will also be an important factor in determining how tall and big you will grow and so on.

How are the genes transferred from one species to another?

A female animal’s egg which has already been fertilised by a male sperm (often by **artificial insemination**) is taken from the oviduct (the tube leading from the ovary to the womb, where fertilisation usually occurs). This fertilised egg is injected with a new gene from a different species (or an altered gene from the same species). This process is called micro-injection; the egg is very small and the whole process is done under the microscope. The egg is then put into the womb of a foster mother who will give birth to a **TRANSGENIC** animal (an animal that has been given a gene from another animal). Often the extraction and implantation of eggs and embryos is done by surgical operation.

So there can be a lot of surgery for donor and recipient animals, performed for no benefit to the animals themselves.

Why do scientists want to produce transgenic farm animals?

These are the main reasons:

- **To increase the amount of milk, meat etc produced by an animal. Scientists aim to make animals grow faster and produce less fatty meat.**
- **To make farm animals resistant to diseases which are usually common in intensive farming systems.**
- **To produce animals which make proteins in their milk/blood for human medicines.**
- **To produce animals whose organs might be used in human transplant operations.**

When were the first transgenic animals produced?

The first transgenic farm animals (sheep and pigs) were produced in 1985.

Growth rates can be speeded up in animals like pigs by inserting extra growth hormone genes, (either more of the pig growth hormone gene, or cow or human growth hormone genes). The transgenic pig should grow more quickly and produce less fatty meat. These characteristics should also be passed on to the piglets. However, there have been some terrible failures. In the USA, pigs that were born with an extra bovine growth hormone gene were lame, with damaged vision, and heart and kidney problems.

How is genetic engineering affecting cows?

Dairy cows can also be given growth hormone genes so that they will produce more milk. One researcher has already predicted much larger cows producing twice as much milk as today's high yielding cow. Scientists are also trying to alter the nature of the milk - e.g. to make it more like human milk or more suitable for making cheese.

What about genetically engineered poultry?

Poultry are being engineered to produce more meat and eggs. A transgenic chicken with a cow growth hormone gene has been developed. Modern broiler chickens already suffer because they grow so quickly - imagine the welfare problems of the transgenic chicken with added cow growth hormone.

Are these experiments successful?

Frequently not. Genetically engineered lambs developed a diabetes-like condition. Calves have grown too big to be born naturally. And of course often the gene doesn't get incorporated properly, and lots of 'failures' can be born. Scientists have applied to get these failures sold as ordinary meat.

Will genetic engineering protect animals from disease?

Attempts are being made to genetically engineer farm animals to make them resistant to disease but as yet there are no successful examples. Chickens which were thought to have been made resistant were instead made to get the disease.

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What is animal 'pharming'?

Experiments are being carried out to produce a protein called AAT (which is used to treat the lung disease emphysema) in the milk of sheep. Although the protein has been produced it has not yet been shown to be effective or safe. This means there will be several years of tests to see if the protein will be useful against emphysema. Before the scientists start testing their new techniques on large animals like sheep, they 'try out' their ideas on many small animals such as mice and rabbits.

Is meat from genetically engineered animals on sale?

Not yet. CIWF Trust believes that if such meat is sold it should be clearly labelled (although we do not think it should be sold in the first place).

What is cloning?

Cloning is the production of a group of genetically identical individuals, derived from a single parent. A sheep named Dolly, announced by scientists in Scotland early in 1997, is the first mammal cloned from the nucleus of an adult cell. In the experiments in which Dolly was produced, 148 out of 156 implanted embryos failed to survive. Two of the dead fetuses, on examination, were found to have abnormal liver development.

And lots of surgical intervention is required. The sheep that donate egg cells undergo hormone injections, followed by surgery to have the egg cells removed. Cloned embryos are sometimes then placed, surgically, in temporary recipient sheep. Six days later these temporary 'foster mothers' are killed, and the embryos removed. The embryos are then placed, again surgically, into the surrogate mother ewes. Some deliveries have been achieved by caesarean section.

Scientists have now begun to combine the techniques of **genetic engineering and cloning**. The same group of scientists that produced Dolly have now created Polly - the first genetically engineered farm animal clone. Both of these techniques - cloning and genetic engineering - have very poor track records, in terms of animal welfare. Combining them could be a disaster for farm animals.

natural selection - a related concept

A cow naturally produces enough milk for her calf - maybe 4 - 5 litres a day. Why does she produce this amount?

Suppose we have a breed of wild cattle which produce only 2 - 2½ litres. Their calves would be undernourished and many of them would not survive.

However, not all cows in the herd would produce the same amount of milk. The calves of mothers who produced slightly more than 4 - 5 litres would be more likely to survive than those which produced less. They would also be more likely to reproduce themselves, and would pass the tendency to produce more milk on to their offspring.

Over many generations, cattle would evolve which produced more milk. This process is called **Natural Selection** and is an important part of the **Theory of Evolution**.

However, Natural Selection will not go on increasing milk yield forever since this would compromise the health of the mother.

Suppose we have a breed of wild cattle which produced 8 - 10 litres of milk per day. The calves would grow particularly well, though they might not need all this milk. Producing all this milk might weaken the mother if she could not find enough food to produce it. Her reserves of fat, protein and essential elements such as calcium might be depleted. She might not survive the next winter or dry season. She might need a year without giving birth to recover her strength.

Either way, she will produce fewer calves. In this case Natural Selection will lead to a reduction in milk yield.

These examples are somewhat fanciful, but Natural Selection does result in a balance between the needs of mother and calf which optimises the chances of genes being passed from generation to generation.

Our understanding of natural selection can help us to understand why **Selective Breeding** (and also **Genetic Engineering**) can result in animal suffering.

Selective breeding is a variation on Natural Selection; in fact it is sometimes called **Artificial Selection**. Here, humans change the selection pressures artificially by, for example, selecting cattle which produce more milk.

If the selective breeding is moderate, this won't necessarily cause suffering. The cattle can be fed larger amounts of more concentrated foods to replace what is lost in the extra milk. However, cattle now produce up to ten times more milk than their ancestors did. Because they are separated from their calf and only milked twice a day, up to 20 to 25 litres of milk will accumulate in the udders, a huge weight for them to carry. Interestingly, if humans had been selectively bred for milk production to the same relative extent, the average mother would produce 6 - 7½ litres of milk a day,

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and hold approximately 1½ - 2 litres of milk in each mammary gland before milking. It is possible to speculate that this would have implications for her welfare.

Few animals that have been selectively bred would survive for long in the wild without losing the traits we have selected for. We have to go to considerable lengths to help them to survive and reproduce. In some cases this is taken to extremes:

1. The broiler chicken. These have been bred so that they grow fast and eat a lot. They reach slaughter weight in 6 - 7 weeks. If spared from slaughter, they rarely live much longer. Their bodies are too large for their life-support systems. They would rarely survive long enough to reproduce. Not surprisingly, this is quite a problem for those who want to breed broilers!

They get round the problem by keeping their breeding stock on “reduced rations” so they grow more slowly and can survive to reproduce. Many believe that these chickens suffer terribly from hunger in the process.

2. Belgian Blue cattle would often die, or lose their calves, in labour but for Caesarean Section.
3. Male turkeys are too large and clumsy to mate. There would be no next generation but for Artificial Insemination.

None of these would reproduce naturally!

Genetic Mutation

Natural Selection or Selective Breeding alone cannot explain how species have evolved. New genes have to appear and these happen by mutation.

These mutations are random changes in genes. Not surprisingly, the vast majority are harmful and result in suffering and/or death. Natural Selection weeds them out. Occasionally, by chance, a “beneficial” mutation occurs and Natural Selection will cause it to spread through the gene pool.

Whilst the choice of gene is less random in the case of genetic engineering, the location of its addition often is random. Since we don't know the function of 98% or so of farm animal DNA, the consequences for the animal can be very hard to predict. The Beltsville Pig given the gene for Bovine Growth Hormone is a classic example. Poor co-ordination and vision, lameness, bone and joint problems, and liver and kidney damage were amongst the side effects.

Our knowledge of the effects of mutations helps us to explain why genetic engineering often results in suffering and/or death to the animals whose genome we operate on.

We cannot prevent natural spontaneous mutations, but we can choose whether or not to subject animals to genetic engineering.

CLASSROOM ACTIVITIES

1. The family debate - an idea for creative writing (or role play)

The scene: Janet Cooper, a genetic engineer, arrives home very excited. She has managed to transfer some cattle growth hormone genes into a chicken. She tells her husband and teenage children (Bob 15 and Lisa 17) that now chickens will grow even faster. They can be slaughtered sooner and therefore farmers will kill more chickens per year and make more money. She is going to patent her invention and hopes to make a lot of money from it.

Husband John likes foreign holidays and fast cars.

Lisa is a vegetarian and belongs to a local animal rights group.

Bob is an active member of his local church and has strong views on “man playing God”.

Imagine how each family member reacts to Janet’s news - and how she reacts to them!

Write a piece of dialogue (or enact a role-play) beginning:

Janet: I can’t wait to tell you all what happened today! Listen to this

2. Are you a Luddite?

People who are against genetic engineering are often told they are “Luddites”. Find out who the Luddites were (clue: early 19th century British history) and how the expression is used today.

Tell us in 300 words why you are:

- a) **a Luddite about genetic engineering of animals, or**
- b) **definitely not a Luddite about genetic engineering of animals, or**
- c) **against genetic engineering of animals but don’t believe you are a Luddite.**

CLASSROOM ACTIVITIES

3. Group discussion topics

Get into groups of 4 or 5 (or 8 for No. 3). Using one of the following situations, choose a character and have a discussion on your chosen subject:

- a) Family of 4 or 5. Brian Jackson, the father, aged 42, has severe heart disease. No human hearts are available for transplant. Possibly he could choose to be the first human recipient in the UK of a heart from a genetically engineered pig. He discusses the situation with his wife, Natalie, and teenage children, Pat who's 18, Dave, 16 and Cindy, 13. (Key words: hopes, fears, worry, love, death, risk, viruses, animal welfare.)
- b) Dairy farmers Gwen and David Jones have been advised to use genetically engineered cow growth hormone injections (BST) to increase the amount of milk from their cows. They discuss this with Mr Shah, their veterinary surgeon, and their children, Bryn who is 17 and Sian, 14. (Key words: BST (bovine somatotropin), mastitis, agribusiness companies, milk yield, productivity, profits, risk, animal welfare.)
- c) (Group of 8) A government advisory committee meets to discuss whether they should advise the Minister to allow the sale of meat from genetically engineered pigs. (The pigs have a cattle growth hormone gene and grow faster and leaner.)

In the discussion:

Professor Mary Baird, chairperson of the committee

Dr Hari Singh, a representative of the university where the genetically engineered pigs were developed

Frances Murphy, a representative of a consumer association

Ted Waddell, a representative of an animal welfare group

Cindy Miller, a PR person for the company selling the pigs

Jack Maitland, a representative of the Meat Sellers' Association

Professor Henry Macdonald, a consultant to the Department of Health

Brenda Griffiths, a representative from a leading supermarket chain

(Key words: opportunity, challenge, public acceptability, fear, risk, profit, animal welfare, consumers, customers.)

CLASSROOM ACTIVITIES

WHERE DO YOU DRAW THE LINE?

4. Notes on use of cards on selective breeding and genetic engineering issues

Suggested lesson outline. Cards should be cut up in advance.

- a) Hand out cards and ask students working in twos, threes or fours to put them on the table. If they believe the contents are totally acceptable they put the card on the extreme left hand side of the desk. Totally unacceptable cards go on the extreme right hand side. Cards they feel neutral about go in the middle, with all shades of opinion in between!
- b) Show video.
- c) Ask students to discuss the video in their groups and to rearrange the cards as appropriate.
- d) Decide where they draw the line on selective breeding and genetic engineering issues.
- e) Have a whole class discussion.

CLASSROOM ACTIVITIES

genetic engineering (1)

Genetically engineering sheep so their milk contains human proteins which can be used in medicine

Sheep are being genetically engineered to produce AAT, a medicine which could be used to treat cystic fibrosis, and the lung disease emphysema.



But is it right that sheep and human genes should be mixed in this way? And should surgery be used on sheep which is of no benefit to the sheep themselves?

Genetically engineering pigs so their organs can be used for transplants

Pig hearts might be able, in the future, to be used to save people with heart disease. But should we risk the possibility of transferring dangerous viruses from pigs into the human population?



And genetic engineering is very unpredictable - what about the experiments on pigs that don't work properly?

Patenting of animals

If an animal is patented not only it but its offspring belongs to the person who genetically engineered it. This will encourage the commercialisation of genetic engineering. Should animals be treated as property like this?



Genetically engineering a larger mouse

This has no use in itself but it was developed as a way of practising the technology. They want larger farm animals, but it is quicker and cheaper to practise on mice.



As with all transgenic animals, several have to be operated on to produce one transgenic mouse. If the procedure is successful it will still have to be repeated on farm animals.

A Ban on Genetic Engineering of Farm Animals

Scientists say that genetic engineering can deliver benefits for mankind.

Animal welfarists say that it can cause animals to suffer.

Should farm animal genetic engineering be banned?



Inserting a gene into soya beans so they are resistant to weedkiller

The weedkiller can then be applied to the crop, killing weeds without killing the crop.

Will it lead to increased use of weedkillers? Could the gene 'escape' from the soya beans into weeds, making weeds immune to weedkiller? Is this a risk worth taking?



CLASSROOM ACTIVITIES

genetic engineering (2)

Engineering a sheep which produces thicker wool

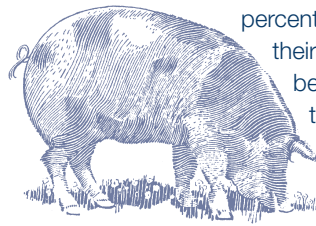
This would increase wool production meaning greater profits for farmers and lower prices for the consumer.



It might interfere with the sheep's metabolism and well-being. An extra thick coat might mean heat stress for the animal; after shearing the greater change in temperature might then result in greater cold stress.

Engineering pigs with the human haemoglobin gene

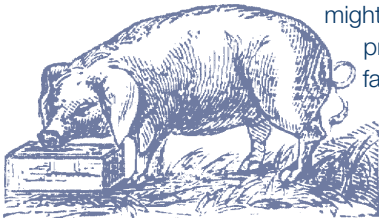
Pigs have been engineered with a small percentage of human haemoglobin in their blood. The idea is to be able to use pig blood for human transfusions.



A great many pigs would need to be experimented upon to develop such a medical technique. There would still be fears of unknown pig viruses spreading to man. If it were successful pigs might need to be kept in sterile conditions with the likelihood that their lives would be barren and dull.

Inserting a growth hormone from cows into pigs so they may grow bigger

It is hoped that this might mean cheaper pig meat. In practice, it hasn't worked so far.



Pigs born with the gene have suffered chronic arthritis and have had to be put down to save them further suffering.

Injecting cows with BST to increase milk yield

Bovine Somatotropin (BST) is a genetically engineered hormone which can be injected into cows to increase milk yield. It should make it easier for farmers to increase milk output.



Unfortunately cows already suffer from the excessive amounts of milk they have been bred to produce and to carry. BST may worsen lameness and mastitis, two conditions associated with high milk yield.

Genetically engineering tomatoes so they ripen more slowly



Tomatoes have been genetically engineered for 'delayed ripening'. It prolongs their shelf-life - but do people really want this?

CLASSROOM ACTIVITIES

selective breeding

Selectively breeding wheat for a higher yield



Food will be cheaper. It will be easier to feed people in poorer parts of the world. The new wheats may need greater use of chemicals.

Selectively breeding pigs for leaner meat

There is a consumer demand for this for health reasons.



However, it may not be good for the pig. Fat helps insulate the pig from the cold. Changes which affect the homeostatic mechanisms of the pig may cause suffering.

Breeding a chicken to grow faster



This means the farmer can grow more chickens per year. The price of chicken should be less.

Fast-growing chickens may have trouble standing, suffer from weak hearts and chronic pain.

Breeding chickens without feathers



Some attempts to keep chickens intensively in hot countries have failed because the chickens died in the heat. In fact heat can be a problem in broiler sheds in the UK in mid-summer.

Featherless chickens might be able to survive in the heat. What their life would be like in hot crowded sheds is another matter.

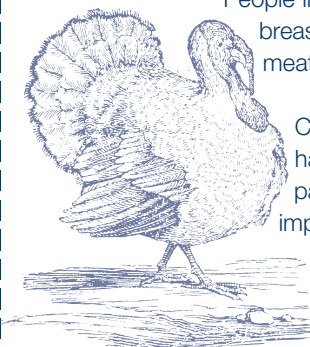
Breeding cows to produce more milk



This helps farmers produce a greater quantity of milk more cheaply.

It places considerable strain on the cow. The weight of milk in the udder can make it difficult for the cow to walk. This causes lameness. Higher milk yields may be associated with mastitis - a painful inflammation of the udder.

Breeding turkeys with larger breasts



People like to eat the white meat of the turkey breast. It helps keep the price of turkey meat down, but the turkey pays the price.

Carrying the extra weight makes it hard for the turkey to walk, and causes painful hip problems. It makes it impossible for the male turkey to mate and means that females have to be subjected to the stress and discomfort of artificial insemination.

CLASSROOM ACTIVITIES

Surgical and Physiological Manipulations of Farm Animals

Artificially inseminating cattle

This means the farmer does not have to keep a bull, which is costly. It also increases the number of offspring that a bull with particular characteristics can have.

It means that the cow has to be restrained for an intensive procedure. The bulls kept to produce semen are often isolated from the company of their own kind.



Artificially inseminating turkeys

Large-breasted birds are too big to walk easily, and they cannot mate successfully. Without artificial insemination it would not be possible to breed birds like this.



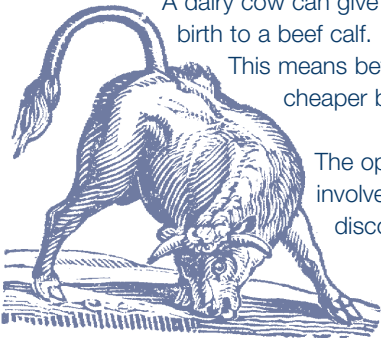
Transferring embryos into cattle so that the calves produce better beef

A dairy cow can give birth to a beef calf.

This means better and cheaper beef.

The operation may involve pain and discomfort for the cow.

In the UK an anaesthetic is required by law.



Cloning a Sheep

Quality sheep can be produced to order, and their embryos placed inside a surrogate mother by embryo transfer.

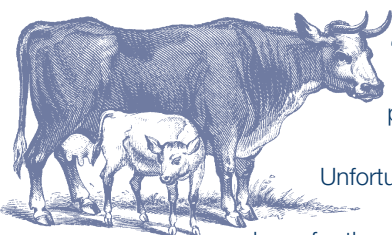
The operation may be stressful for the sheep and cause pain afterwards. All the young could be susceptible to the same diseases.



Breeding cattle which often have to be born by Caesarean Section

Belgian Blue cattle are "double-muscled" at the back. This means they produce extra meat.

Unfortunately, it means that their rear quarters are often too large for the calves to be born naturally and they frequently have to be delivered by Caesarean Section.



Cloning beef cattle

Steaks are not all the same. If you know a particular cow or bull produces particularly good steak, then the clones should be the same.

But many cloned calves are abnormal, growing to twice the normal size at birth. 10% of cloned calves have other abnormalities, for example joint problems. Cloning also involves subjecting cows to embryo transfer.



CLASSROOM ACTIVITIES

5. quote/unquote

Below are various statements made by eminent people either involved with, or concerned about, genetic engineering. Discuss these quotes in small groups (4 - 5). Do you agree or disagree with the various points being made? Perhaps you could rank them in order of -

- Strongly Agree
- Agree
- Not Sure
- Disagree
- Strongly Disagree

Compare your results with other groups and then work out a general result for the class. How much does the class result vary from your original group choices?

“At the moment, as is so often the case with technology, we seem to spend most of our time establishing what is technically possible, and then a little time trying to establish whether or not it is likely to be safe, without ever stopping to ask whether it is something we should be doing in the first place.”
HRH the Prince of Wales, The 1996 Lady Eve Balfour Memorial Lecture, London 19.9.96

“Transgenic animals illustrate man’s final violation of those with whom he shares this world. He has controlled them ‘externally’; now he seeks to condition them ‘internally’, an absolute form of slavery.”
Dr Tony Sargent, in “Animal Rights and Wrongs”, London, 1996: Hodder and Stoughton, p222

“While the scientists have learnt to be precise about the way they replicate genes, the process of insertion and expression is still very imprecise, and its results unpredictable. All policy should therefore be made within a context that recognises our relative lack of knowledge and that genetic engineering can have unexpected results.”
Dr Michael Hansen (Consumers Union, USA), Food of the Future: the risks and realities of biotechnology, Conference Proceedings, Consumers’ International, The Netherlands, 16 - 17th November 1995

CLASSROOM ACTIVITIES

5. quote/unquote

“We therefore conclude that it would be ethically unacceptable to use primates as source animals for xenotransplantation, not least because they would be exposed to too much suffering ... We conclude that the use of the pig for xenotransplantation may be ethically acceptable. We conclude further, however, that the acceptability lies in balancing the benefit to humans against harm both to the pig and to humans.”

“Animal Tissue into Humans - A report by the Advisory Group on the Ethics of Xenotransplantation”, London, 1997: The Stationery Office, p65-66

“Do we reduce all life to technology? Do we genetically engineer all farm animals? Do we turn them into chemical ‘factories’ for the production of pharmaceuticals? Or, do we restore our proper relationships and recentralise our values with other creatures?”

Dr Jeremy Rifkin, in “Animal Genetic Engineering”, London, 1995: Pluto Press, p35

“...the technique [genetic engineering] provides a mechanism for the transfer of genes across wide distances of biological separation, so that essentially the entire resource of genetic information in nature is available for redistribution between species as appropriate.”

Dr Kevin Ward, in “Animal Genetic Engineering”, London, 1995: Pluto Press, p41

“When the gene responsible for cystic fibrosis is introduced into mice it affects their size as well as their lungs, in which a lot of mucus accumulates. The animals also show intestinal obstructions so such animals will be very useful in the long run for developing new therapies for the treatment of this devastating disease.”

Dr. Elaine Dzierzak, in “Animal Genetic Engineering”, London, 1995: Pluto Press, p181- 2

CLASSROOM ACTIVITIES

5. quote/unquote

“How will we feel about hundreds of transgenic dogs and monkeys being genetically manipulated to develop tumours or painful chronic diseases? Public opposition to genetic engineering of farm animals, creatures familiar to us from childhood, is already greater than the opposition to the use of mice. We can expect levels of concern to escalate to enormous heights when cats, dogs and primates become involved.”

Dr Gill Langley, in *“Animal Genetic Engineering”*, London, 1995: Pluto Press, p193

“We are playing not just with fire but with dynamite”

Sir Crispin Tickell, chairman of Government Advisory Panel on Biotechnology, referring to the possible escape of genetically engineered organisms into the environment. The Independent 26.1.96

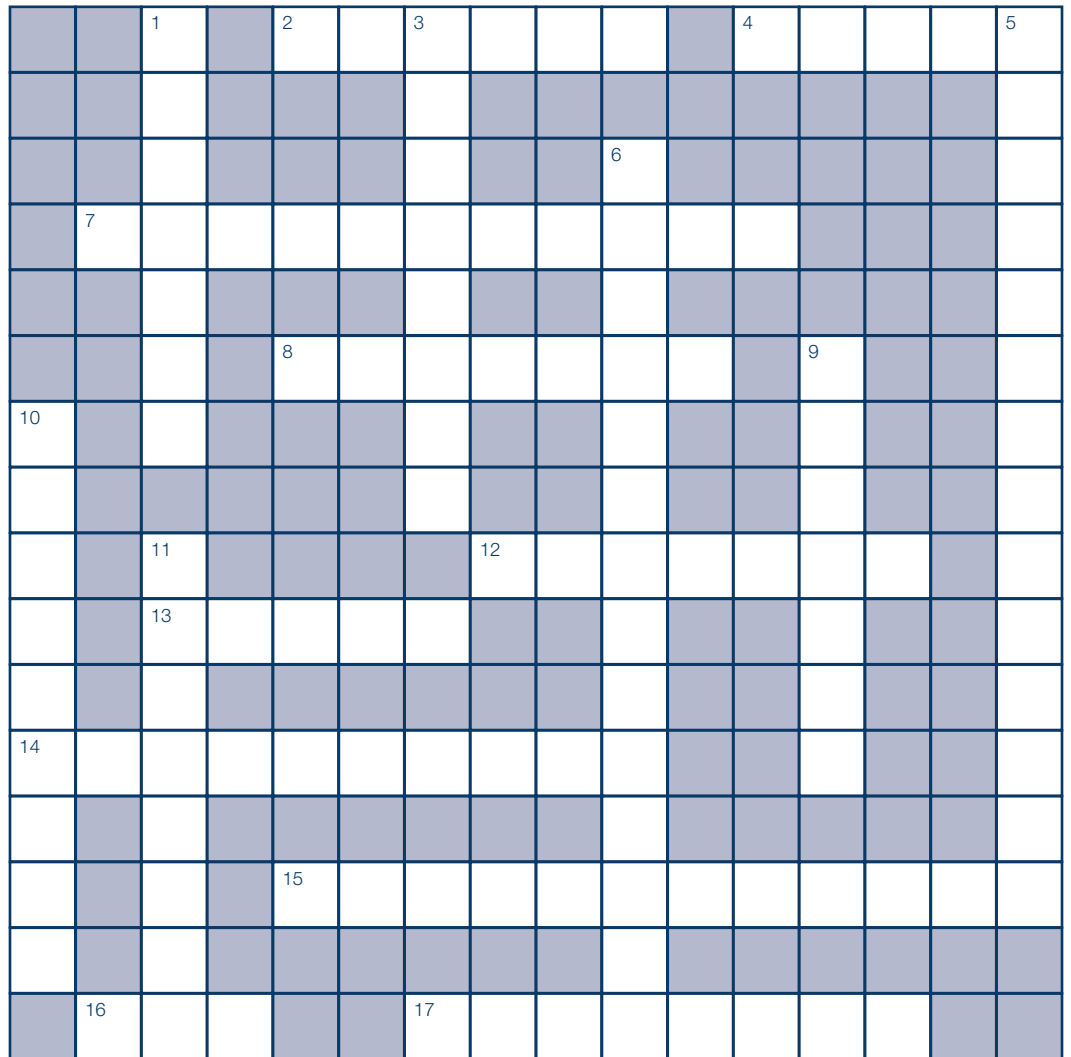
“We believe this can cause great suffering to the animals in terms of painful births and caesarean operations. It should be banned.”

Joyce D’Silva, Director of Compassion in World Farming, referring to cloning of sheep. Sunday Times 27.7.97

CLASSROOM ACTIVITIES

6. Try to solve this puzzle

19 genetic engineering



Across

- 2) With 17 across, surgically implanting an embryo into a uterus (6)
- 4) Inherited from your parents, they code for proteins (5)
- 7) See 12 across (11)
- 8) Like the geep, half sheep, half goat (7)
- 12) With 7 across, inserting genes from one species into another (7)
- 13) Grows very large in cows with high milk yield (5)
- 14) Of an animal which has foreign DNA in its genome (10)
- 15) Done artificially to impregnate a female (12)

16) The stuff that genes are made of (3)

17) See 2 across (8)

Down

- 1) How Dolly became genetically identical to her mum (7)
- 3) See 10 down (8)
- 5) Making the ovary produce lots of eggs at once (14)
- 6) How foreign genes are added to eggs (14)
- 9) A chicken grown for meat (7)
- 10) With 3 down, egg developing a chicken which grows faster (9)
- 11) Spontaneous change in a gene (8)



CLASSROOM ACTIVITIES

6. Solution

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		O				E			⁶ M						P
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¹⁰ S		G				N			O			R			V
E						G			I			O			U
L		¹¹ M						¹² G	E	N	E	T	I	C	L
E		¹³ U	D	D	E	R			J			L			A
C		T							E			E			T
¹⁴ T	R	A	N	S	G	E	N	I	C			R			I
I		T							T						O
V		I		¹⁵ I	N	S	E	M	I	N	A	T	I	O	N
E		O							O						
	¹⁶ D	N	A				¹⁷ T	R	A	N	S	F	E	R	

glossary

Agribusiness: that part of the business world which is concerned with agriculture.

Amino acids: molecules which link together to form proteins.

Artificial insemination: the procedure whereby female animals are made pregnant using sperm collected previously from males.

Biotechnology: the application of biological systems or processes to the manufacture of specific products. Includes genetic engineering technology.

Broiler: a chicken reared for meat.

BST (bovine somatotropin): a cattle growth promoter. Genetically engineered BST (rBST) is being used in the United States to make cows produce more milk.

Caesarean section: a surgical operation to allow young to be born via an incision made through the abdomen, and into the womb.

Chimera: an animal composed of cells that are not all genetically identical, eg the “geep” produced in the 1980s. Part of this animal was goat; part was sheep.

Chromosomes: the thread-like structures which carry the genes, present in the nucleus of every cell in the body.

Cloning: the practice of artificially producing two or more genetically identical organisms.

DNA: deoxyribonucleic acid; a complex informational molecule, in the form of a double-helix, present in the nucleus of all cells; DNA determines the basic characteristics of any organism; DNA is composed of sequences of genes; chromosomes contain DNA.

Embryo: an organism in the early stages of pre-natal development.

Embryo transfer: artificially moving an embryo from its natural mother, to a “surrogate” mother, in which the embryo develops to birth.

Evolution: the changes which occur in living things, over thousands of years, brought about by random genetic mutations and the operation of natural selection.

Foetus: a mammal in the later stages of pre-natal development.

Gene: the smallest segment of DNA controlling an inheritable trait.

glossary

Genetic engineering: the direct manipulation of the genetic material of an organism, in order to affect the organism's biochemical characteristics, and thus its development.

Genome: the total genetic information carried by the chromosomes of an organism; every cell generally contains the full genome.

Genotype: the genetic make-up of an organism, as determined by the set of genes that it carries.

Homeostasis: the physiological process whereby internal bodily systems (eg body temperature, blood pressure etc) are kept at equilibrium despite changes in external environmental conditions.

Mastitis: a painful disease of the mammary gland in mammals, common in the udders of modern dairy cows bred to produce very large quantities of milk. Injection of cows with rBST is associated with increased levels of mastitis. Breast-feeding human mothers sometimes develop mastitis too.

Microinjection: the introduction of foreign genes into the newly-fertilised eggs of an animal, by direct injection of the foreign DNA into the egg cells.

Mutant: an organism whose genetic material has been modified.

Mutation: any alteration, random or deliberate, to a gene.

Natural selection: the process by which those living things best suited to an environment are the ones which survive; "the survival of the fittest".

Oocyte: a cell in the ovary which undergoes cell-division to form the ovum, or egg cell.

Oviduct: that part of the female reproductive system which receives the egg from the ovary, and in which fertilisation normally occurs. It leads to the uterus.

Pharming: the deliberate production from genetically engineered animals of proteins which have pharmaceutical (and commercial) importance, such as medicines.

Phenotype: how the products of genes in an animal interact with the environment and affect that animal's characteristics, eg behaviour, susceptibility to disease, hair-colour.

Proteins: naturally occurring molecules composed of a sequence of amino acids; proteins generally form structural components of an animal, or act as enzymes. Hair is made up of the protein 'keratin'. Saliva contains the protein 'salivary amylase', an enzyme which assists digestion.

glossary

Recombinant DNA: a hybrid DNA molecule which contains DNA from more than one source.

Selective breeding: the deliberate breeding of two animals, in order to exaggerate a specific characteristic. In this way, broiler chickens have been developed which grow much more quickly than their wild ancestors.

Superovulation: the artificial production of an abnormally large number of egg cells by a female animal. It is most often achieved by giving the female animal a series of hormone injections.

Transgenes: new DNA sequences (either from a different species, or altered sequences from the same species), introduced into an animal with the objective of altering the target animal's biochemical characteristics, and therefore its development.

Transgenic animal: an animal into which new DNA sequences have been deliberately introduced.

Transomics: the introduction of whole new miniature chromosomes into target cells; this technique potentially allows the introduction of significantly larger amounts of genetic material than can be achieved with other techniques such as microinjection.

Virus: a sub-cellular organism which reproduces only inside an appropriate host cell, and outside of which it is totally inert. Made up of a nucleic acid core and a protein shell.

Xenografts: tissues or organs transplanted from one species into an individual of a different species, sometimes called **xenotransplants**.

Zygote: the product of fertilisation of the ovum by the sperm, and from which the whole organism develops.

directory of organisations - genetic engineering

Advocates for Animals

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Dr Hadwen Trust for Humane Research

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Friends of the Earth (FoE)

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SAFE Alliance

Sustain (the alliance for better food and farming)

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Soil Association

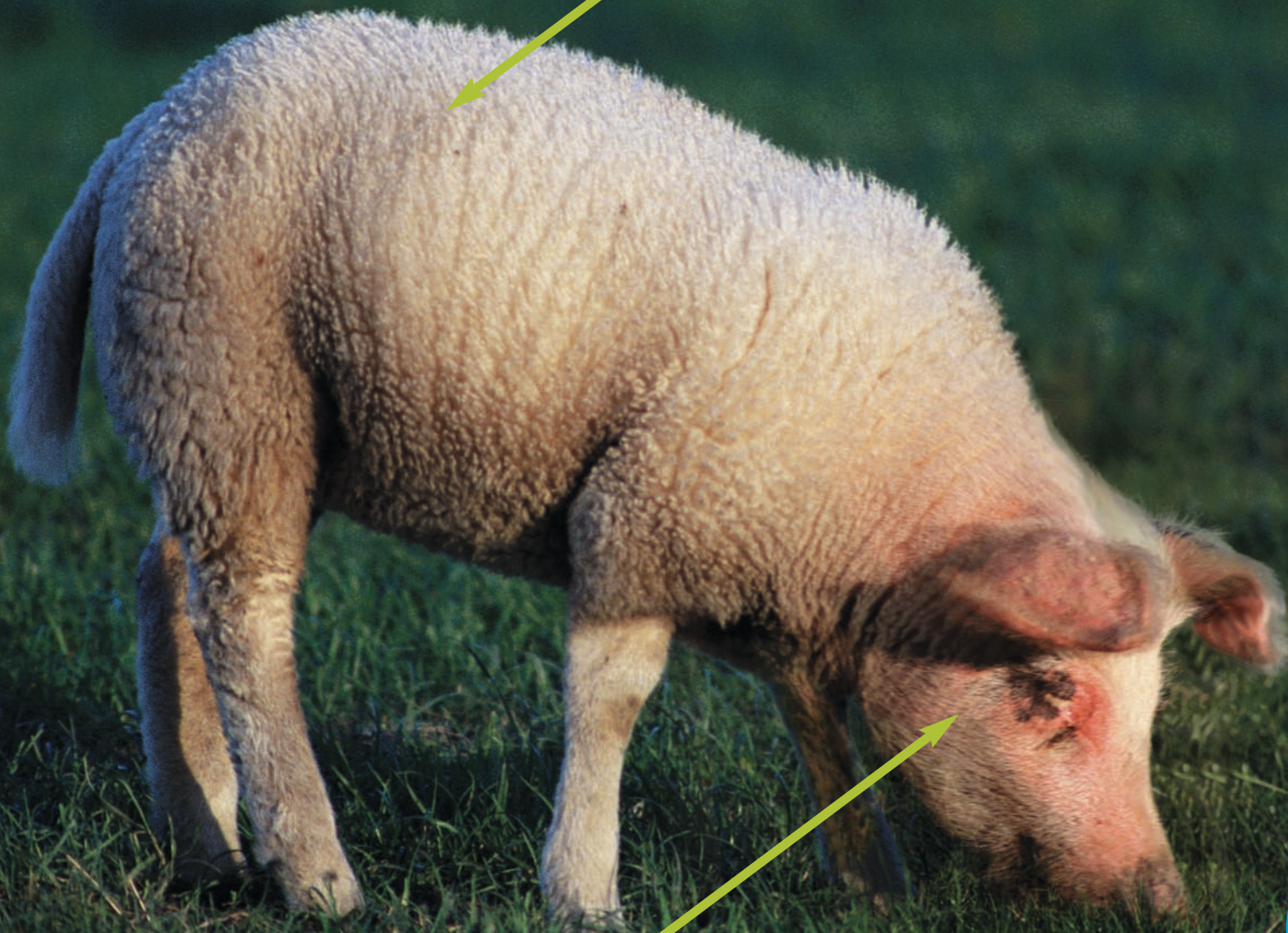
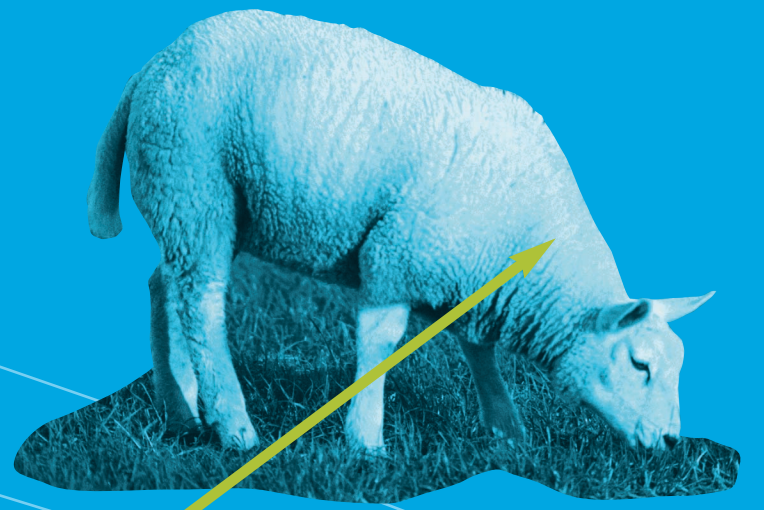
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genetic engineering

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