



Clone 1: Be my own personal slave e.g. cook, clean etc.



Clone 2: Teach on Mondays so I can have a 3 day weekend



Clone 3: Be my personal 'queuer' at theme parks

**If you had 3 clones, what would you get them to do?!**

**Aim high: How would you clone yourself?!**

Genetic  
engineering

Genetic and  
environmental  
differences

## B1.6 Variation

Inheritance

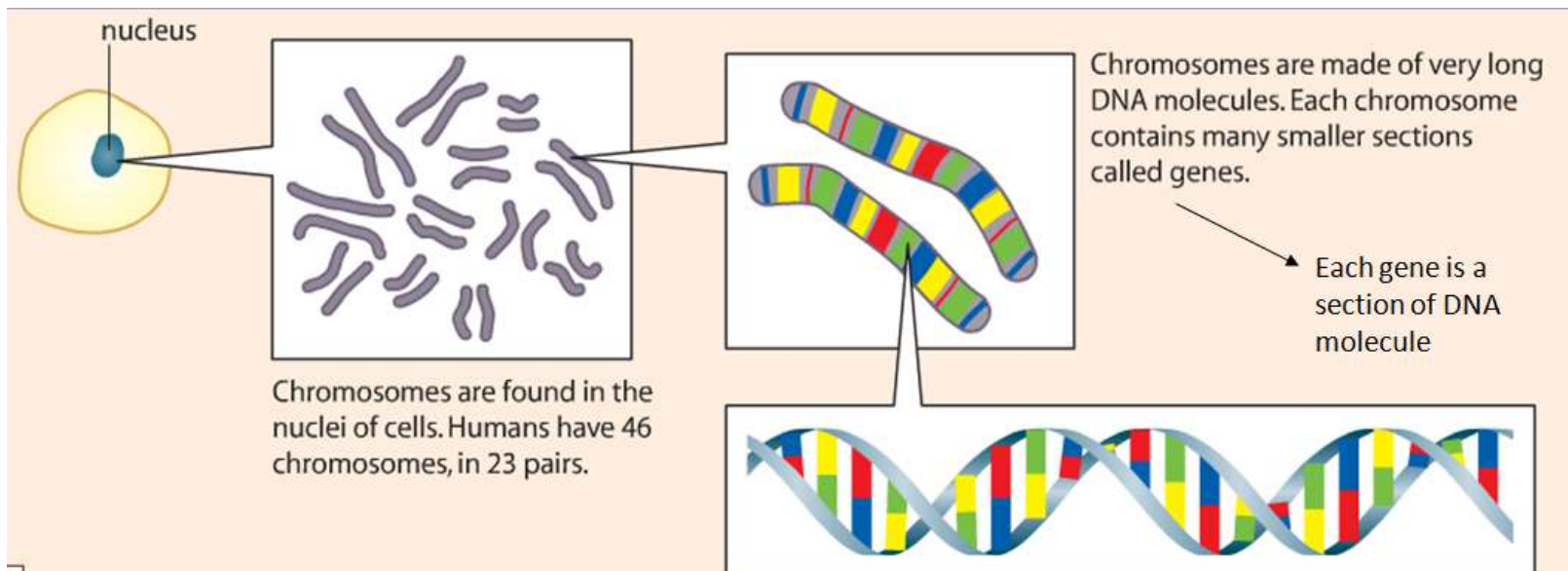
Cloning plants

Types of  
reproduction

Cloning animals

# Inheritance

- Genetic information is in the **nucleus** of cells
- Inside the nucleus are **chromosomes** made up of **DNA** – humans have 46 chromosomes (23 pairs)
- **Genes** are a section of DNA and control enzymes and proteins made in your body
- Genes are passed on to you in the sex cells (**gametes**) from your parents – they come in pairs



# Types of reproduction

## Sexual reproduction

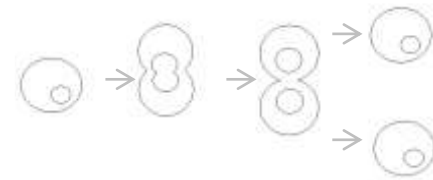
- Male sex cell and female sex cell
- Risky as the two have to meet
- BUT provides genetic variation important for survival
- E.g. Mammals, birds



**Advantages** – allows evolution, variation, increases chances of species survival  
**Disadvantages** – need to find a partner, waste energy. Waste in producing gametes, slower

## Asexual reproduction

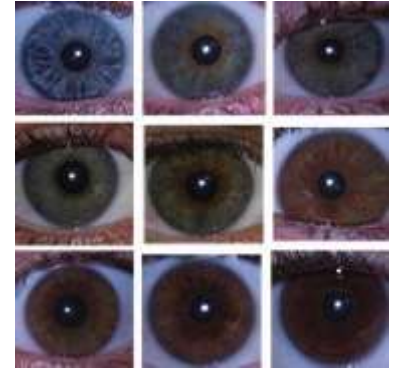
- One parent
- No genetic variation – clones
- Cells of body reproduce asexually – divide in two for growth and repair
- E.g. Bacteria, strawberries



# *Genetic and environmental differences*

## Nature – **genetic** variety

- E.g. Eye colour, gender, shape of nose



## Nurture – **environmental** variety

- E.g. Scars, accents, drinking when pregnant

## Combined causes of variety

- E.g. Height, weight



Investigating variety: scientists study twins adopted by different families compared to identical twins brought up together and non-identical twins

# Plant cloning

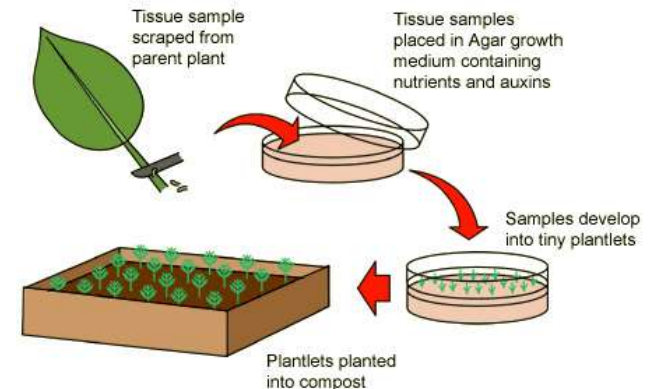
## Cuttings

- Remove a small section of the plant
- New roots and shoot will form to give you a new plant
- Rooting powders and moisture will help the process
- Quick and cheap
- Genetically identical plants
- Used commercially for orchids and fruit trees



## Tissue culture

- Expensive but allows thousands of new plants from tiny piece of plant
- Use plant hormones to make a small group of cells produce a big mass of identical plant cells
- Using hormones these can then form a new plant
- This guarantees all plants will have the desired characteristics

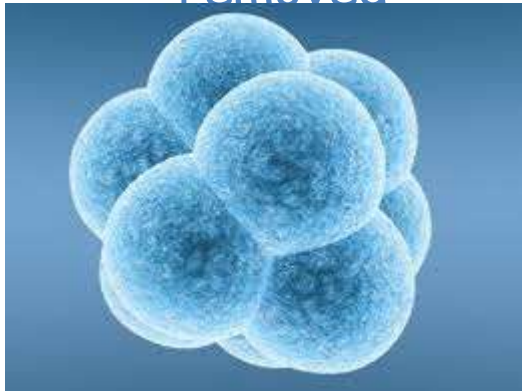
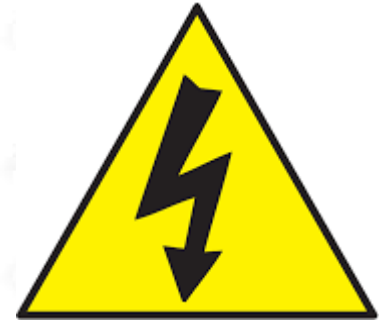
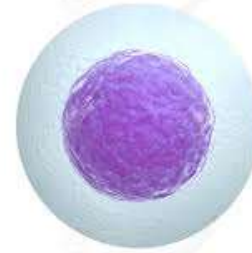


# Nuclear transfer/adult cell cloning

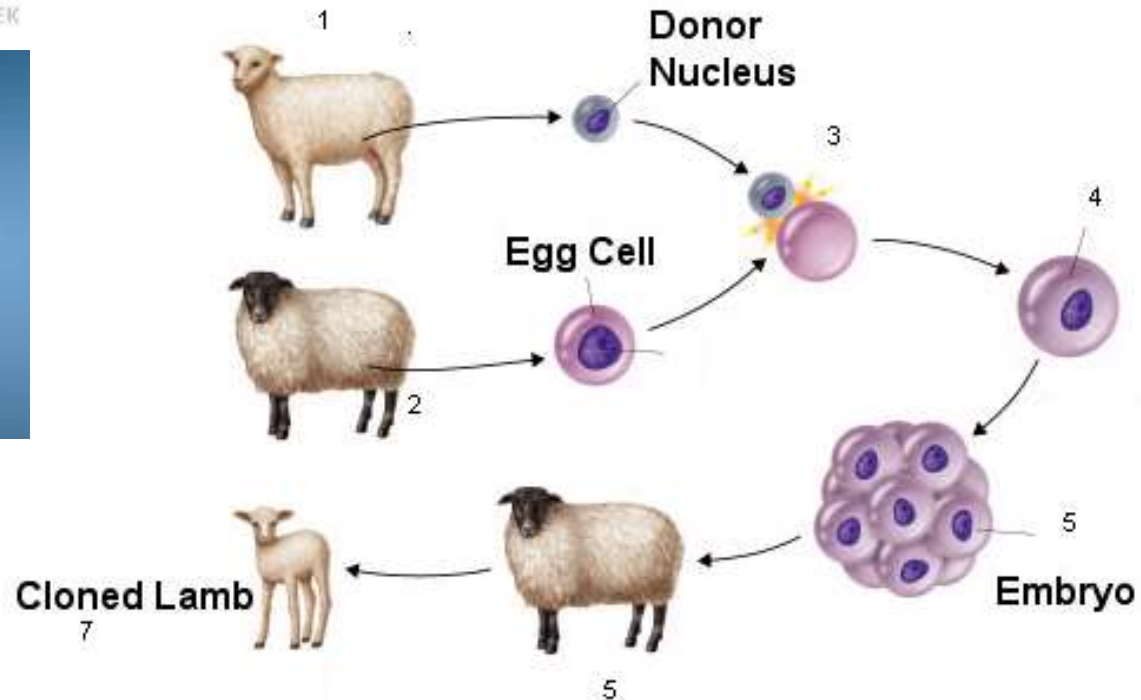


removed

wiseGEEK



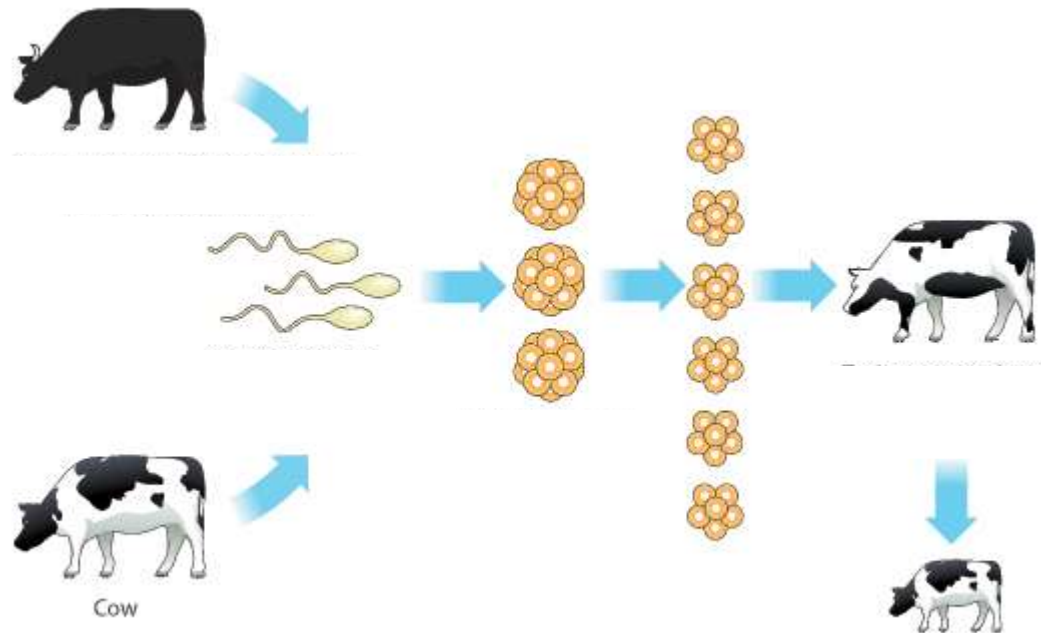
fused using an electric shock



# Embryo transplant Cloning

↓  
Embryos are split into smaller embryos,  
each of which can grow into a calf  
↓  
Embryos are inserted into uterus of  
foster mothers

Sperm is taken from  
a bull  
↓  
Cow is artificially  
inseminated  
↓  
Zygotes develop into  
embryos in cow and  
are then removed  
from uterus



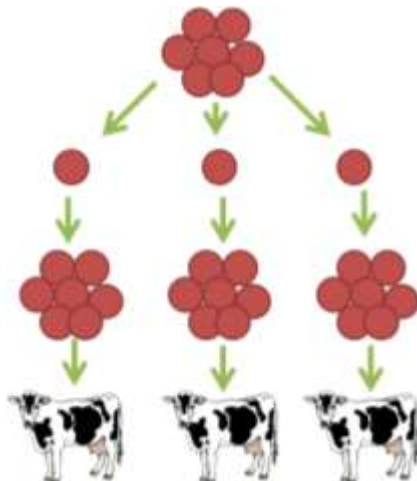


# Animal cloning

## Embryo cloning

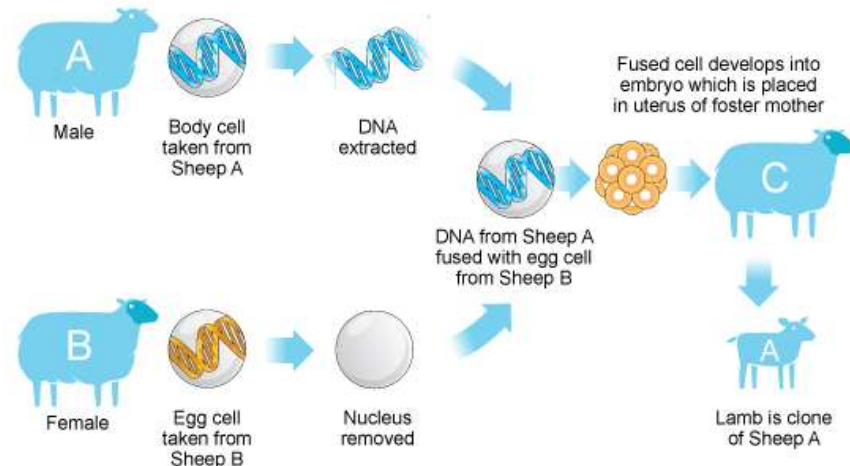
- Best cow given fertility hormones to produce lots of eggs and fertilise from best bull
- Divide each embryo into individual cells - Each cell grows into an identical embryo in the lab
- Transfer embryos into surrogate mothers - Identical cloned calves born

**Advantages:** high quality embryos taken to poor places and produce lots of milk / meat. Can make lots of identical copies of genetically modified embryos that produce genetically useful compounds



## Adult cell cloning

- **Advantages:** Save animals from extinction, Bring back prized animals, Clone genetically engineered, medically useful animals (e.g. Those with useful proteins in their milk)
- **Disadvantages:** Could lead to cloning humans – ethics? Abuse of science – cloning for organs, Reduces variety – species less able to adapt if there is a change (*usually some of the species will survive and reproduce but not if we are all clones*)

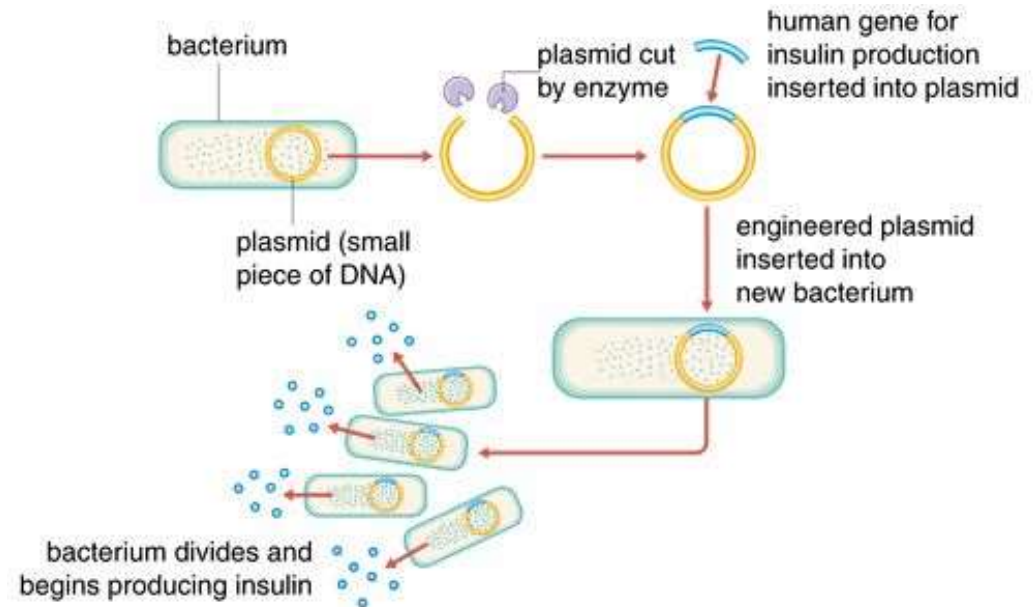


# Genetic engineering

- Changing the genetic material of an organism
- A gene is taken from one organism and transferred into the genetic material of a different organism



## Genetic engineering – insulin



### Advantages

- Bacteria can make human medicines and hormones
- Improve the growth rates of plants and animals
- Improve the food value of crops
- Reduce the fat levels in meat
- Produce plants that make their own pesticide chemicals
- Crop plants give off a blue light so farmers know when to spray with pesticides
- Possible cures for genetic diseases

### Disadvantages

- Insects may become pesticide-resistant if they eat a constant diet of pesticide-forming plants
- Effect on human health of GM unknown
- Genes from GM plants might spread to wildlife / environment
- GM crops are often infertile so farmers would have to buy new seeds each year
- People may want to manipulate the genes of their own children

### Human engineering:

Genetic diseases can be very serious  
It might become possible to insert 'healthy' genes into the affected cells using genetic engineering

# ***Exam questions***

6 The picture shows a zebra fish.



Illustration © Emily S. Damstra

Zebra fish are small freshwater fish that usually have black and silver stripes. Zebra fish can tolerate a wide range of environmental conditions.

6 (a) Scientists have genetically modified zebra fish to act as pollution indicators. The genetically modified zebra fish have a gene transferred from a jellyfish. The gene allows the stripes of the zebra fish to change colour.

Describe how the scientists produced the genetically modified zebra fish.

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(3 marks)

6 (b) Some scientists are worried about the production of genetically modified zebra fish. Suggest reasons why.

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.....

(2 marks)

6 (a)	<p>(jellyfish) gene(s) cut out</p> <p>ref to enzymes (at any stage)</p> <p>(gene) transferred to zebra fish at early stage of development / embryo / egg</p>	<p>ignore removal of zebra fish genes</p>	<p>1</p> <p>1</p> <p>1</p>
6 (b)	<p>any two from:</p> <ul style="list-style-type: none"> <li>• could transfer gene to other (fish) species</li> <li>• effects on food chains</li> <li>• effects on zebra fish themselves, eg may out compete non GM zebra fish</li> </ul>	<p>ignore unethical / religious / unnatural</p> <p>accept effects on other species / humans who eat them</p>	2

1

The photograph shows a zorse.



A zorse is a cross between a male zebra and a female horse.  
The zorse has characteristics of both parents.

1 (a) The zorse was produced by *sexual reproduction*.

1 (a) (i) What is *sexual reproduction*?

.....  
.....

(1 mark)

1 (a) (ii) The zorse has characteristics of a zebra and a horse.

Why?

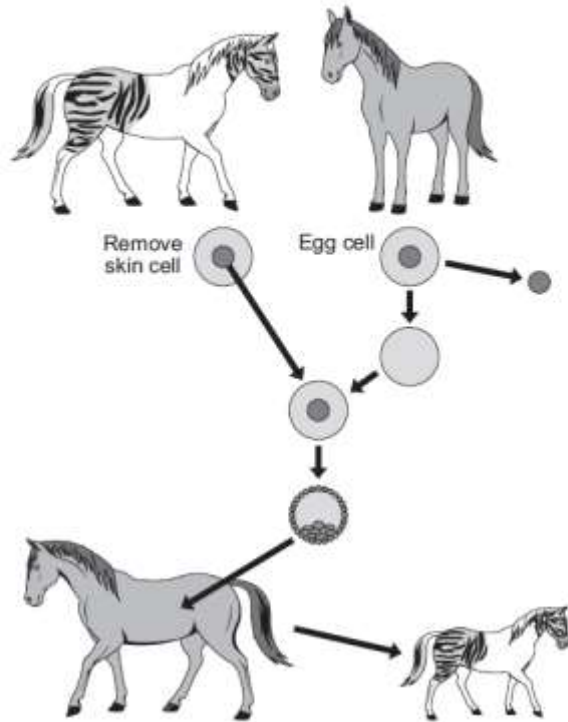
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(2 marks)

1 (b)

Zorses are **not** able to breed.  
Scientists could produce more zorses from this zorse by adult cell cloning.

The diagram shows how the scientists might clone a zorse.



*In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Use information from the diagram and your own knowledge to describe how adult cell cloning could be used to clone a zorse.

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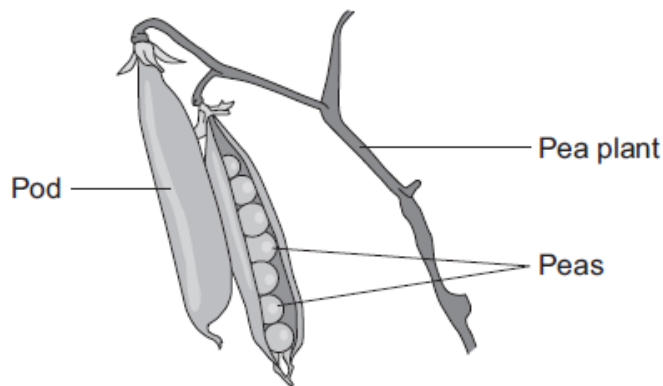
[6 marks]

question	answers	extra information	mark
1(a)(i)	fusion / joining / combining of gametes / egg and sperm / sex cells	accept fertilisation  allow fusion / joining / combining DNA from two parents  ignore meeting / coming together / mixing of gametes etc	1
1(a)(ii)	(mixture of) genes / DNA / genetic information / chromosomes	ignore nucleus / inherited information but allow second mark if given	1
	from both parents / horse and zebra	dependent on sensible attempt at 1 <sup>st</sup> mark	1

1(b)	Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 2, and apply a 'best-fit' approach to the marking.		
0 marks	Level 1 (1–2 marks)	Level 2 (3–4 marks)	Level 3 (5–6 marks)
No relevant content	There is simple description of the early stages of adult cell cloning. However there is little other detail and the description may be confused or inaccurate.	There is an almost complete description of the early stages of the process and description of some aspects of the later stages. The description may show some confusion or inaccuracies.	There is a clear, detailed and accurate description of all the major points of how adult cell cloning is carried out.
<p>Examples of Biology points made in the response could include:</p> <ul style="list-style-type: none"> <li>• skin cell from zorse</li> <li>• (unfertilised) egg cell from horse</li> <li>• remove nucleus from egg cell</li> <li>• take nucleus from skin cell</li> <li>• put into (empty) egg cell</li> <li>• (then give) electric shock</li> <li>• (causes) egg cell divides / embryo formed</li> <li>• (then) place (embryo) in womb / uterus</li> </ul>			6



1 Peas grow in pods on pea plants.



A gardener grew four varieties of pea plants, **A**, **B**, **C** and **D**, in his garden. The gardener counted the number of peas in each pod growing on each plant.

The table shows his results.

Variety	Range of number of peas in each pod	Mean number of peas in each pod
<b>A</b>	2–6	4
<b>B</b>	3–7	5
<b>C</b>	3–8	6
<b>D</b>	6–8	7

1 (a) Give **one** environmental factor and **one other** factor that might affect the number of peas in a pod.

Environmental factor .....

Other factor .....

(2 marks)

1 (b) The gardener thinks that he will get the largest mass of peas from his garden if he grows variety **D**.

Why is the gardener **not** correct?

Suggest **one** reason.

(1 mark)

<b>1(a)</b>	<p>any correct named physical environmental condition, e.g. light / water / rain / temperature / minerals / nutrients / space (between plants)</p> <p>genes / inheritance OR any correct named biotic factor e.g. predation / disease</p>	<p>ignore carbon dioxide / climate / weather / sun / pollution</p> <p>ignore 'variety'</p>	<p>1</p> <p>1</p>	
<b>1(b)</b>	<p>mass of crop also depends on number of pods (per plant) / size / mass of each pea</p>	<p>ignore number of plants</p>	<p>1</p>	