There are many ways to increase the efficiency of food production.

(a) The table shows the energy available to humans from two different food chains.

<table>
<thead>
<tr>
<th>Food chain</th>
<th>Energy transferred to humans in kJ per hectare of crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat → humans</td>
<td>900 000</td>
</tr>
<tr>
<td>Wheat → pigs → humans</td>
<td>90 000</td>
</tr>
</tbody>
</table>

(i) Compare the amount of energy the two food chains transfer to humans.

______________________________________________________________

(ii) Give one reason for the difference in the amount of energy the two food chains transfer to humans.

______________________________________________________________
Give methods used in the factory farming of animals.
Explain the advantages and disadvantages of these methods.
Tomatoes are grown in greenhouses in the UK and outdoors in the UK and the Canary Islands.
The chart shows in which months these tomatoes can be bought in shops in the UK.

<table>
<thead>
<tr>
<th>Canary Islands</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Canary Islands are about 3000 km from the UK.

Some people prefer to buy tomatoes grown in the UK.

What are the advantages and disadvantages of buying tomatoes grown in the UK, instead of buying tomatoes grown in the Canary Islands?

**Advantages** of buying tomatoes grown in the UK

_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________

**Disadvantages** of buying tomatoes grown in the UK

_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________

(Total 3 marks)
Food security is when a population has enough food to stay healthy.

Lack of food security is a global problem.

One way to maintain food security is to increase the efficiency of food production.

The diagram below shows how some pigs are farmed using intensive methods.

(a) Some people think the farming methods shown in the diagram above are unethical.

Suggest **two** other possible disadvantages of intensive farming methods.

1. _________________________________________________________________
   ___________________________________________________________________

2. _________________________________________________________________
   ___________________________________________________________________

(2)
(b) Explain how the intensive farming of pigs increases the efficiency of food production.
A newspaper reported that:

‘Food security is a serious problem in remote communities in Canada. This is because Aboriginal communities are eating fewer traditional foods.’

One traditional food eaten by Aboriginal communities in Canada is seal.

Look at the table below

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of seals caught in thousands</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>362</td>
</tr>
<tr>
<td>2005</td>
<td>316</td>
</tr>
<tr>
<td>2006</td>
<td>348</td>
</tr>
<tr>
<td>2007</td>
<td>224</td>
</tr>
<tr>
<td>2008</td>
<td>215</td>
</tr>
<tr>
<td>2009</td>
<td>91</td>
</tr>
<tr>
<td>2010</td>
<td>67</td>
</tr>
</tbody>
</table>

Calculate the percentage (%) decrease in the number of seals caught from 2004 to 2010.

___________________________________________________________________

___________________________________________________________________

Decrease in seals = ______________________ %

(2)

The conclusion in the newspaper might not be correct.

Suggest two reasons why.

1. _________________________________________________________________

___________________________________________________________________

2. _________________________________________________________________

___________________________________________________________________

(2)

(Total 10 marks)
In this country most tomatoes are grown in greenhouses.

(a) Suggest one way in which a grower could increase the yield of tomatoes from plants growing in his greenhouse.

___________________________________________________________________

___________________________________________________________________

(1)

(b) Large supermarkets often import tomatoes from overseas.

(i) Suggest two reasons why a supermarket might decide to import tomatoes rather than buy them from British growers.

1. ____________________________________________________________
   ____________________________________________________________

2. ____________________________________________________________
   ____________________________________________________________

(2)

(ii) Importing tomatoes may be more damaging to the environment than selling tomatoes grown in this country.

   Explain why.

   _______________________________________________________________________________________

   _______________________________________________________________________________________

   _______________________________________________________________________________________

   _______________________________________________________________________________________

   _______________________________________________________________________________________

(2)
Some of Britain’s rarest wild flowers are likely to make a come-back thanks to an EC set-aside regime in which 15 per cent of arable land has been taken out of production.

As a result of this set-aside, shepherd’s needle, pheasant’s eye, corn gromwell, corn cockle, spreading hedge parsley and corn mouse tail are now thriving once again. They were once common in and around cereal fields and were even regarded as weeds, but were swept to near extinction by the intensification of agriculture after the Second World War. Their small, pale flowers are hardly seen. These plants cannot compete in fields where modern cereal crops are cultivated. Nor, however, do they flourish in semi-natural or wild habitats where nature is left to its own devices. They need farmland which is lightly tilled and cut once a year.

Dr Nick Sotherton, lowland research manager with the Game Conservancy Council, says that these species will flourish under the new rotational set-aside regime, in which farmers are compensated for taking land out of production in an attempt to end crop surpluses.

EC agriculture ministers are meeting to decide how much land should be used for rotational set-aside – in which a field is taken out of production for just one year before being replanted – and how much should be set-aside permanently. The ultimate set-aside is a wood, and Britain is seeking a forestry option.

The Game Conservancy Council says that the rotational scheme can benefit ground nesting birds as well as rare flowers that will not be helped by longer-term set-aside. But Richard Knight of the Wildlife Advisory Group, says “Non-rotational is better because it gives flora and fauna a chance to get well established”.

“Intensification of agriculture” has led to the creation of artificial ecosystems.
(a) Explain how the creation of artificial ecosystems may have led to the near-extinction of the plants seen in the picture above.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(4)

(b) What would you recommend to ministers meeting to decide a policy involving rotational set-aside and permanent set-aside? Explain the reasons for your answer.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
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___________________________________________________________________
___________________________________________________________________

(4)

(Total 8 marks)
(a) The diagram shows what happens to each 1000 kJ of light energy absorbed by plants growing in a meadow.

Use the information from the diagram to calculate:

(i) how much energy was transferred to herbivores;

___________________ kJ

(ii) the percentage of the energy absorbed during photosynthesis that was eventually transferred to carnivores. Show your working.

___________________ %
(b) The table gives the energy output from some agricultural food chains.

<table>
<thead>
<tr>
<th>FOOD CHAIN</th>
<th>ENERGY AVAILABLE TO HUMANS FROM FOOD CHAIN (kJ PER HECTARE OF CROP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>cereal crop ⇒ humans</td>
<td>800 000</td>
</tr>
<tr>
<td>cereal crop ⇒ pigs ⇒ humans</td>
<td>90 000</td>
</tr>
<tr>
<td>cereal crop ⇒ cattle ⇒ humans</td>
<td>30 000</td>
</tr>
</tbody>
</table>

Explain why the food chain cereal crop ⇒ humans gives far more energy than the other two food chains.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(3)
(c) The amounts of energy available to humans from the food chain 
\( \text{cereal crop} \Rightarrow \text{pigs} \Rightarrow \text{humans} \)
can be increased by changing the conditions in which the pigs are kept.

Give **two** changes in conditions which would increase the amount of energy available. In each case explain why changing the condition would increase the available energy.

Change of condition 1

Explanation

___________________________________________________________________

___________________________________________________________________

Change of condition 2

Explanation

___________________________________________________________________

___________________________________________________________________

(4)
(Total 10 marks)
Battery Pigs!

Some countries have battery pigs! Large numbers of pigs are kept indoors and have limited living space which restricts their movement. The temperature of their environment is carefully controlled.

This is a way of producing food efficiently.

These pigs have their movement restricted. Explain why.

_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________
(Total 2 marks)
Chickens are kept as farm animals to produce food. Free-range chickens are allowed to feed in a large space outside. The diagram shows how energy supplied in food to a free-range chicken is transferred.

(a) Calculate the amount of energy “lost” in faeces.

___________________________________________________________________

___________________________________________________________________

Energy “lost” = ______________ kJ

(1)

(b) Some farmers use the battery method. They keep large numbers of chickens in a small indoor space. The food yield from these chickens is higher than that from free-range chickens. Explain why, as fully as you can.

___________________________________________________________________

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(4)

(Total 5 marks)
The information in the table compares two farms. Both are the same size, on similar land, close to one another and both are equally well managed.

<table>
<thead>
<tr>
<th>Name of farm</th>
<th>Activity</th>
<th>Energy value of food for humans produced in one year</th>
<th>Number of people whose energy requirements can be met by this food</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenbank Farm</td>
<td>Grows food for humans</td>
<td>3285 million kJ</td>
<td>720</td>
</tr>
<tr>
<td>Oaktree Farm</td>
<td>Grows food for animals on the farm which become food for humans</td>
<td>365 million kJ</td>
<td>80</td>
</tr>
</tbody>
</table>

(a) Use this information to work out the average daily human energy requirement in kilojoules (kJ) per day.

___________________________________________________________________

___________________________________________________________________

Energy requirement = ________________ kJ/day

(b) The figures show that farms like Greenbank Farm can be nine times more efficient at meeting human food energy requirements than farms such as Oaktree Farm.

(i) The food chain for Greenbank Farm is:

vegetation → humans

What is the food chain for Oaktree Farm?

___________________________________________________________________

(ii) Explain why Greenbank Farm is much more efficient at meeting human food energy requirements.

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

(3)
The human population has been increasing rapidly throughout this century. It is now about 6 billion and is still growing. What does the information in this question suggest about likely changes in the human diet which may need to occur during the coming century? Explain your answer.

The graph shows the variations in the North Sea herring population between 1952 and 1974. These fish were formerly caught in large numbers by fleets of trawlers but fishing has been restricted since 1974 as a conservation measure. Herrings lay about 20 000 eggs per year but do not reproduce until they are about 3–5 years old, when they are about 25cm long. It takes 11 years for a herring to reach its mature adult length.
The following measures have been suggested to prevent overfishing:

• limiting mesh size of nets,
• specifying maximum catch by each boat per year.
• prohibiting fishing in herring breeding grounds.
• prohibiting fishing at certain times of the year.

Evaluate their probable effects on both fish stocks and the fishermen, using the information given above.

(Total 9 marks)

Scientists have found the following food web in the cold Antarctic Ocean.

![Food Web Diagram]

(a) Humans are removing large numbers of the cod.

Some scientists argue that this could lead to a decrease in the numbers of squid and penguins.

Others argue that the numbers of squid and penguins will stay the same.

Carefully explain each argument.

Why they might decrease.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(1)

Why they might stay the same.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(2)
(b) The following information is about the biomass of the organisms in one of the food chains in the web.

```
<table>
<thead>
<tr>
<th>tiny green plants</th>
<th>shrimp</th>
<th>cod</th>
<th>seal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 tonnes</td>
<td>100</td>
<td>10</td>
<td>0.5</td>
</tr>
</tbody>
</table>
```

Draw and label a pyramid of biomass for this chain.

(c) Explain, as fully as you can, why the conversion of shrimp biomass into cod biomass is more efficient than that of cod biomass into seal biomass in the cold Antarctic Ocean.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(3)

(d) Boats from many countries fish the Antarctic Ocean. The cod are being overfished. If the numbers of cod are to increase, the population must be carefully managed.

(i) Suggest two control measures which would prevent a further drop in numbers,

___________________________________________________________________
___________________________________________________________________

(2)
(ii) Suggest why one of your control measures would be difficult to put into practice.

________________________________________________________________________

________________________________________________________________________

(1)
(Total 11 marks)
(a) (i) wheat → humans chain transfers 10 times more energy than wheat → pigs → humans chain

\[\text{allow } 10\% \text{ if given as a comparison e.g. one is } 10\% \text{ of the other}\]

or

wheat → pigs → humans chain transfers 810 000 (kJ per hectare) less

\[\text{ignore less unqualified}\]

(ii) any one reason for energy loss from pigs e.g:

\[\text{ignore respiration, growth}\]

\[\text{ignore heat unqualified}\]

• movement

• (maintaining) body temperature

• waste materials

\[\text{allow named examples}\]

• not all parts of pig eaten by human

• because there is an extra stage (pigs) in the food chain and energy is lost at each stage

\[\text{allow longer food chain so more energy lost}\]

(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 in the Marking guidance, and apply a ‘best-fit’ approach to the marking.

0 marks
No relevant content.

Level 1 (1-2 marks)
There is a basic description of at least one factory farming method or identification of an advantage or disadvantage of factory farming.

Level 2 (3-4 marks)
There is a description of at least one factory farming method and an advantage or disadvantage is explained.

Level 3 (5-6 marks)
There is a description of factory farming methods and advantage(s) and disadvantage(s) are explained.
Examples of Biology points made in the response:

factory farming methods e.g.:

- Kept in cramped conditions / battery hens / calf crates / pig barns / fish tanks
- Controlled temperature / heating
- Controlled feeding / modified food given / growth hormones
- Controlled lighting
- Treated with prophylactic antibiotics

Advantages e.g.:

- Increased efficiency / profit / greater food production / cheaper food / faster growth
- Farmer can have more livestock
- Less energy is lost through movement
- Less energy is used keeping warm
- (Food is high in calories / protein) so animals will grow faster / lay more eggs
- Easier to vaccinate all the animals
- Easier to protect animals from predators
- Antibiotic treatment stops infections in animals

Disadvantages e.g.:

- Stress / cruelty / inhumane / unethical
- Restricted movement / overcrowding
- Faster spread of diseases
- Antibiotics in the food chain / residual chemicals in the food chain
- Wasting fossil fuels / increasing global warming
- Increased pollution from animal waste and from additional transport
any three from:

maximum 2 marks if only advantages or only disadvantages given
ignore references to cost unqualified

advantages: (max 2)

ignore reference to fresher

• less transport / example of transport or less fuel used
  accept implication eg less food miles
  allow no transport / fuel costs

• less pollution / example
  accept eg less carbon dioxide / smaller carbon footprint
  allow no pollution / example

• support of local / UK economy / farmers

disadvantages: (max 2)

• not available all year

• may require use of heat / light

• (production of) heat / light causes pollution

(a) any two from:

• diseases spread more rapidly

• antibiotics can build up in the food chain
  or
  over use of antibiotics

• increased use of fossil fuels (to heat the barn)
Level 2 (3–4 marks):
Clear statements made identifying the farming methods which are linked to relevant explanations of how this increases the efficiency of food production.

Level 1 (1–2 marks):
Simple statements made identifying the farming methods used, but no attempt to link to explanations of how this increases the efficiency of food production.

0 marks:
No relevant content.

Indicative content

statements:
• kept inside or in a temperature controlled environment
• kept enclosed or in a restricted environment

explanations:
• less energy / heat is lost in controlling body temperature
• less energy required for movement
• so more energy is available for growth
• less energy / heat is transferred to the environment

(c) \( \frac{362 - 67}{362} \times 100 \)
allow 81 / 81.49 / 81.5

allow 81 / 81.49 / 81.5 with no working shown for 2 marks

(d) aboriginal people can eat other foods (so they may not be in food insecurity)
we do not know if other (traditional) food sources have declined

(a) any one from:
• increase / give light
• increase temperature / make warmer
award marks if the method by which these could be done is given eg leave lights on all night or use a heater
• increase / give CO₂
• add fertiliser / nutrients / minerals / named
  allow nitrogen
  ignore ‘food’
(b) (i) any two from:

- cheaper
  *allow grow faster / more grown*
- better quality / flavour
  *ignore size*
- available all year
  *accept converse if clear that answer refers to use of British tomatoes*  
  *allow ‘Fair Trade’*

(ii) any two from:

- greater distance or more food
  miles or more transport
  *idea of more needed only once*
- transport needs (more) energy / fuel
- reference to eg greenhouse effect / global warming / pollution / CO₂ release / carbon footprint
  *ignore ozone*

(a) 4 of:

intensification due to need to improve efficiency of energy transfer;
has led to developing fast growing crop varieties;
native plants cannot compete with these;
for e.g. light/water/minerals;
effect of herbicides;
pesticides killing pollinating insects

*each for 1 mark*

(b) recommend a variety of measures; (can be implied)
because rotational will allow these species to continue;
permanent will allow others;
leading to conservation of a wide range of species

*each for 1 mark*
(a) (i) 200 kJ
   for 1 mark

(ii) 2
   gains 2 marks
   (if answer incorrect, 20 / 1000 × 100 gains 1 mark)

(b) ideas that
   energy lost by animal (pig / cattle) / extra stage / extra trophic level
   in waste materials e.g.
   in muscular activity / movement
   in keeping body temperature higher than surroundings / lost as heat
   any three for 1 mark each
   references to respiration regarded as neutral

(c) ideas that
   controlling (high) temperature of surroundings / keeping indoors / insulating
   reduces energy transferred from animal as heat / animal uses body heat to maintain
   temperature restricting movement (e.g. caging or keeping in darkness)
   reduces muscular contraction / muscular activity
   each for 1 mark
   accept respiration as explanation once only if neither explanation
   point has received credit
   reject give more food / different food

   to reduce energy 'lost' (by movement)
   accept need less energy
   so more energy is available for growth
   accept prevents loss of body mass to provide energy
   accept so need less food
   accept get fatter
   accept so weight gain
   accept so more growth

(a) 115
(b) any four from

less energy lost / used

as heat lost to the atmosphere

since warm indoors

\(\text{accept temperature controlled}\)

(less energy lost) in movement

since movement restricted

more growth / eggs

\(\text{accept prevents loss of body mass or gets fatter / weight gain}\)

(a) 12 500

\(\text{incorrect numerical answer but clear evidence of correct working}\)

e.g. 365 million \(\div\) 365 \(\div\) 80 or 3285 million \(\div\) 365 \(\div\) 720 \text{ credit with (1)}

(b) (i) vegetation

\(\rightarrow\) (farm) animals \(\rightarrow\) humans

\(\text{accept any correct variation on this theme}\)

e.g. grass \(\rightarrow\) lambs \(\rightarrow\) humans

(ii) any three linked points from

* less links in the food chain

\(\text{or only one link in the food chain}\)

* energy ‘wasted’ or ‘lost’ or

‘used’ at each link

* energy ‘wasted’ or ‘lost’ in (the process of) respiration

* energy ‘used’ to maintain body temperature

* energy ‘used’ by the animals in movement

(c) people will eat more/greater proportion

of food from plants

\(\text{accept people will eat less/smaller proportion of food from animals}\)

\(\text{do not credit ‘everyone will stop eating meat’}\)
any three linked points from
these marks are independent of the ‘prediction’ mark
do not credit ‘food from plants will become less expensive’

* meat will become more expensive
* only a limited area of land
  available on the planet (for food production or otherwise)
* more people means less land
  available for food production
  because some used for housing etc.
* land will become more expensive
* land will have to be used more efficiently
  or more people will go hungry
  or people will (each) eat less

* livestock farmers will try to improve efficiency
* (leading to) growth of ‘factory farming’
* demand for food will rise (total)

ideas that:

large mesh
allows small fish to escape so they live long enough/grow big enough to breed
maintains stocks

close season
maintains stocks
unless catch more in rest of time
especially important in breeding season

closed areas
maintains stocks
especially important for breeding grounds
but can’t make fish stay inside area

quotas
maintains stocks
plus difficulty of enforcement of any/all of above
any 7 for 1 mark each

fisherman (effect of controls on)
reduced catches/less income :: controls
harder to catch fish
but will ensure their future
any 3 for 1 mark each
to max. of 9
(credit other good but unanticipated reasons)
(a) **Decrease:** seals will eat more squid and penguins

*for 1 mark*

**Stay the same:**

- more shrimp/food for squid and penguins

*ideas that*

- increase in squid and penguins balances the extra eaten by seals
- seals find other prey (*allow start to eat shrimps*)

*any two for one mark each*

(b) 

- correct shape (doesn't need to be to scale)
- correctly with organisms

*(if wholly correct but inverted then credit 1 mark)*

*each for 1 mark*

(c) 

- seals are mammals
- *idea that* seals have (to maintain) a constant body temperature [*allow warm blooded]*
- heat losses to cold seas
- more of food eaten used to replace heat loss

*(credit use of figures i.e. 95% loss compared to 90% or 5% efficient compared to 10% or 20 : 1 conversion ratio compared to 10 : 1 with 1 mark)*

*any three for 1 mark each*
(d) (i) ideas that

- reduce number of fishing boats allowed
- breed in captivity and then release
- agree quotas [not an unqualified ‘ban’]
- avoid breeding areas
- avoid breeding seasons
- increase size of net mesh/don’t catch small fish
- limit catches of shrimps
- cull seals

any two for 1 mark each
[allow any other reasonable answer]

(ii)

- breeding areas closer to some countries than others
- difficult to police/easy to cheat/’poach’
- difficult to agree quotas
- some countries eat more fish than others
- best weather for fishing maybe in breeding seasons
- fisherman/trawlers need employment
- big demand for cod

any one for 1 mark
[allow any other sensible response]