

IB Biology

Revision

Topic 3.5 Biotechnology

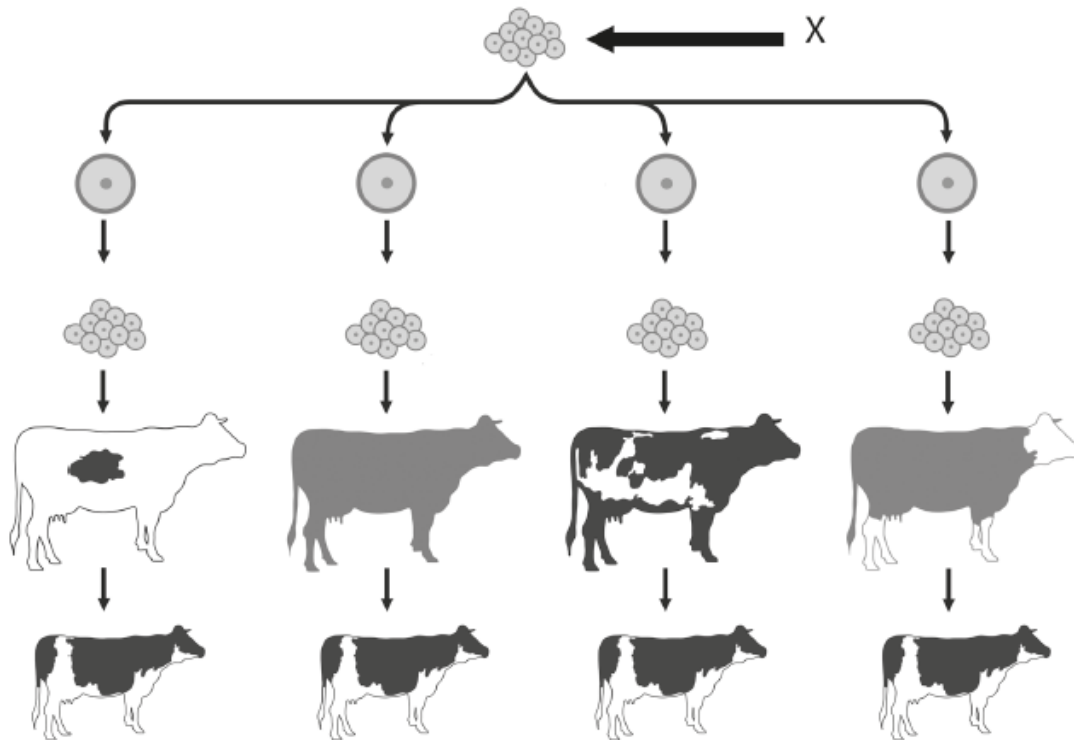


Name:

Teacher: Mr Trent

1. [1 mark]

A cloning method used for livestock involves in vitro fertilization (IVF) with selected male and female gametes. The diagram shows the steps followed after in vitro fertilization.



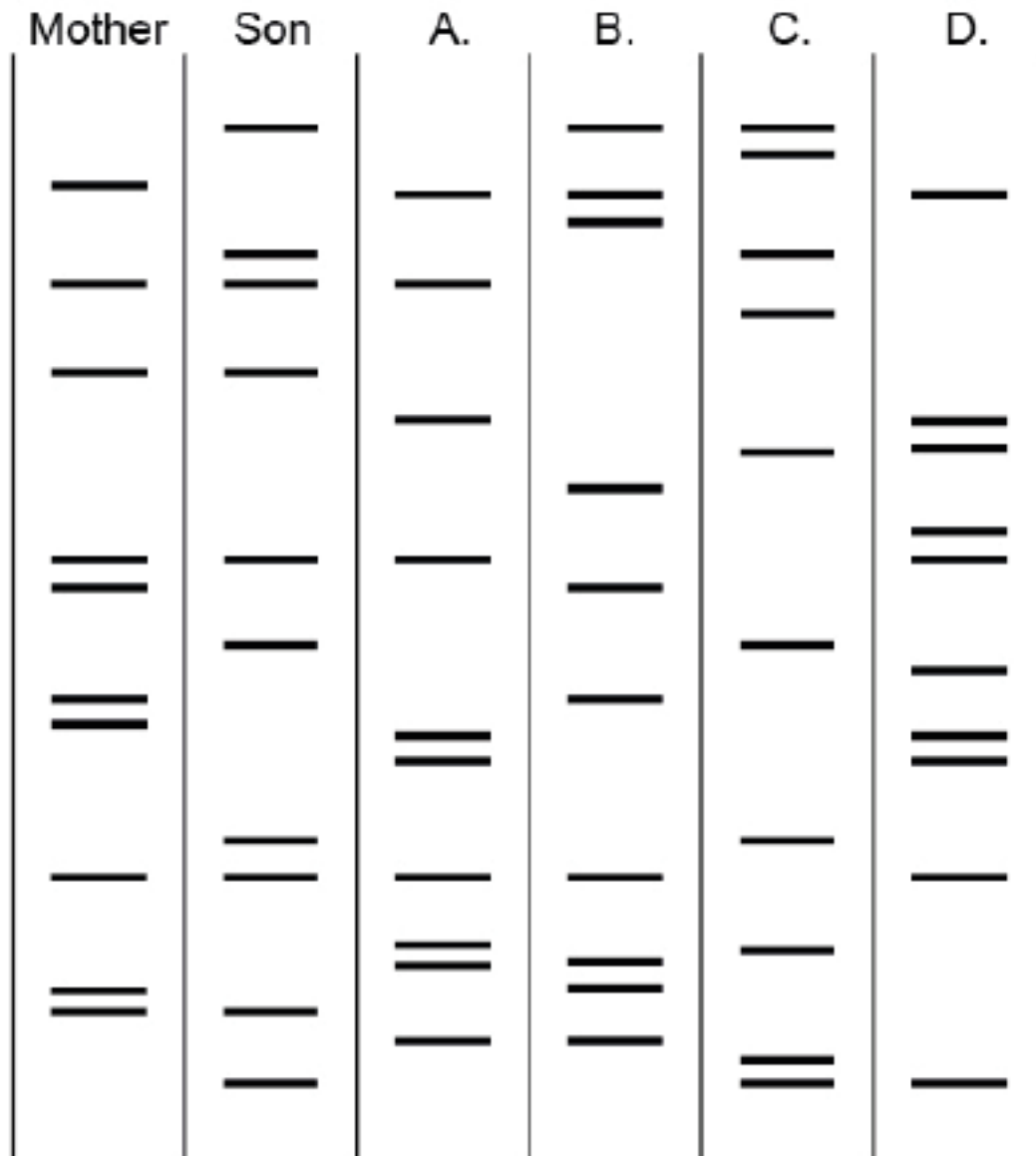
[Source: Aldona Griskeviciene / Shutterstock.com.]

What does X represent?

- A. A group of eggs
- B. An embryo
- C. A follicle
- D. A group of zygotes

2. [1 mark]

The image shows the result of DNA profiling of a mother, a child and four men. Which man is most probably the father of the child?



3. [1 mark] A nucleus was removed from a cell of sheep P and fused with a denucleated egg cell of sheep Q. This was transplanted into the uterus of sheep R, which gave birth to Dolly.



Which describes Dolly?

- A. A clone of sheep P, because Dolly was formed from the nucleus of its udder cell
- B. A clone of sheep Q, because Dolly was formed from one of its egg cells
- C. A clone of sheep R, because Dolly developed in its uterus
- D. Not a proper clone, as more than one sheep was involved in the development

4. [1 mark]

A dihybrid cross was carried out between two plants to determine whether the genes for seed shape and colour are linked. If the genes are unlinked, the expected ratio of 9:3:3:1 should occur. A chi-squared test was carried out on the observed results of the cross. The critical value for chi squared at the 5 % level of significance in this test was 7.82. The calculated value for chi squared was 6.25. What can be concluded from this data?

- A. The results prove that the genes are linked.
- B. The results prove that the genes are unlinked.
- C. There is significant evidence that the genes are linked.

D. There is significant evidence that the genes are unlinked.

5. [1 mark]

What benefit is derived from the use of Bt crops?

- A. It can lead to an increase in genetic diversity of crop species.
- B. Genetically modified species can interbreed with native species.
- C. The numbers of monarch butterflies can be permanently reduced.
- D. It can lead to a reduction in the use of pesticides.

6. [1 mark]

In fruit flies (*Drosophila melanogaster*), grey bodies (b^+) are dominant to black bodies (b) and normal wings (vg^+) are dominant to vestigial wings (vg). Homozygous vestigial winged, black bodied flies were crossed with individuals that were heterozygous for both traits. 2300 individuals were counted and the phenotypes observed were recorded as shown.

965 normal wings, grey bodies
944 vestigial wings, black bodies
206 vestigial wings, grey bodies
185 normal wings, black bodies

Which statement is valid?

- A. The predicted phenotypic ratio was 9:3:3: 1.
- B. There is independent assortment of wings but not body colour.
- C. The expected number of vestigial winged, grey bodied flies was 575.
- D. The traits are on different chromosomes.

7. [1 mark]

Many commercially produced bananas are triploid instead of diploid. The nucleus of a triploid cell has three sets of chromosomes. What is the effect of triploidy?

- A. Seeds are larger.
- B. Chromosomes cannot pair in meiosis.
- C. Sexual reproduction is more rapid.
- D. Mitosis cannot occur.

8. [1 mark]

What is PCR used for?

- A. Separate fragments of DNA by size
- B. Amplify small amounts of DNA
- C. Compare DNA samples
- D. Genetically modify organisms' DNA

9. [1 mark]

William Bateson and Reginald Punnett used the sweet pea (*Lathyrus odoratus*) in genetics studies in the early 20th century. Pure-breeding plants that produced purple flowers and long pollen grains were crossed with pure-breeding plants that produced red flowers and round pollen grains. The resulting offspring all produced purple flowers and long pollen grains. Two of the F₁ generation plants were crossed. The table shows the ratio of phenotypes in the F₂ generation.

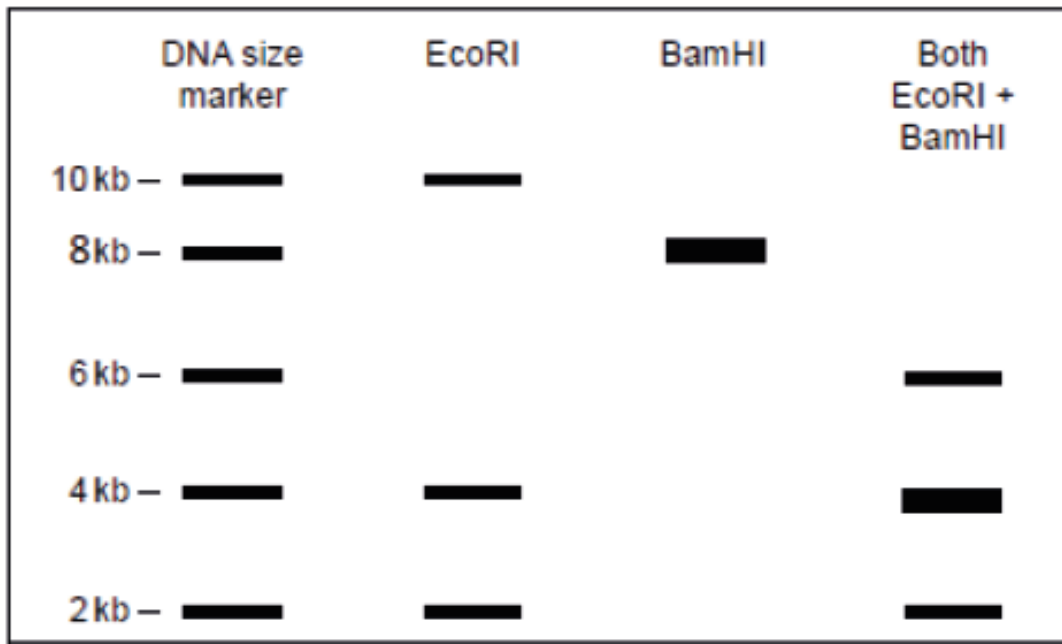
Flower colour	Pollen grain shape	Number of plants
purple	long	4831
purple	round	390
red	long	393
red	round	1138

What is an explanation for these experimental results?

- A. Purple flowers and long pollen grains are dominant and the alleles have assorted independently.
- B. The genes for flower colour and pollen shape are linked and all plants producing long pollen grains are recombinants.
- C. The genes for flower colour and pollen shape are linked and all plants producing red flowers are recombinants.
- D. Plants producing purple flowers and round pollen grains arose through crossing over.

10. [1 mark]

Two restriction endonucleases (EcoRI and BamHI) were used to cut a DNA sample into smaller fragments. These were then subjected to gel electrophoresis and the results are shown. The lengths of the DNA fragments are measured in kilobases (kb). One kilobase is 1000 DNA bases.



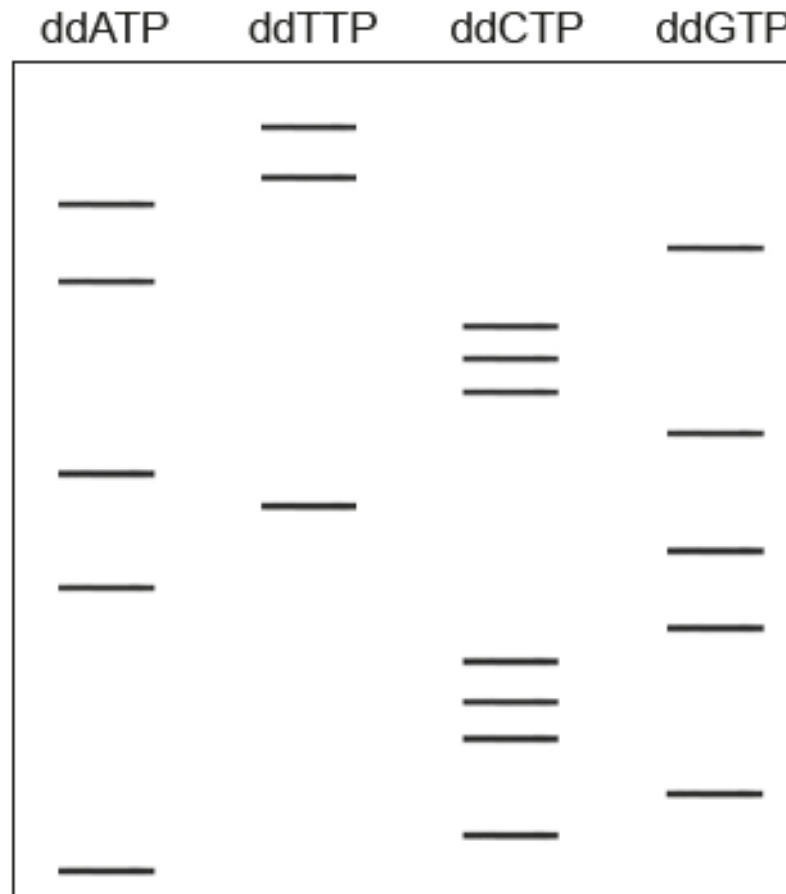
[Source: © International Baccalaureate Organization 2019]

Which statement is supported by the data?

- A. The DNA sample is approximately 16 kb in size.
- B. Each endonuclease produces a 2 kb fragment.
- C. Both endonucleases produce the same number of fragments.
- D. The fragments produced using both endonucleases are all different from those produced by the individual endonucleases.

11. [1 mark]

Sanger developed a method for determining DNA base sequences using terminating nucleotides called dideoxynucleotides. After an incubation period, the DNA samples are run on an electrophoresis gel. Results are shown in the diagram.



[Source: © International Baccalaureate Organization 2018]

What is the base sequence of the original DNA template strand?

- A. ACGCCCGAGTAGCCAGATT
- B. UGCGGGCUCAUCGGGUCUAA
- C. ACGCCCGAGUAGCCAGAUU
- D. TGC GGGCTCATCGGGTCTAA

12. [1 mark]

Which technique is used to amplify very small samples of DNA?

- A. Cloning
- B. Gel electrophoresis
- C. PCR
- D. DNA profiling

13. [1 mark]

*Hind*III is an endonuclease that recognizes the sequence A A G C T T, cutting between the two adenines.

5' T T A A G C T T A A G A A G A A G C T T 3'
3' A A T T C G A A T T C T T C T T C G A A 5'

Into how many DNA fragments would the strand shown be cut by *Hind*III?

- A. 2
- B. 3
- C. 4
- D. 5

14. [1 mark]

Which structure found in eukaryotes has a single membrane?

- A. Nucleus
- B. Lysosome
- C. Chloroplast
- D. Mitochondrion

15. [1 mark]

Which is a possible risk associated with a genetic modification of crops?

- A. Crop plants will become weaker with time.
- B. It can increase mutations in the organisms that consume them.
- C. Starch obtained from genetically modified plants will be more difficult to digest.
- D. Resistance to herbicide genes can be transferred to weeds.

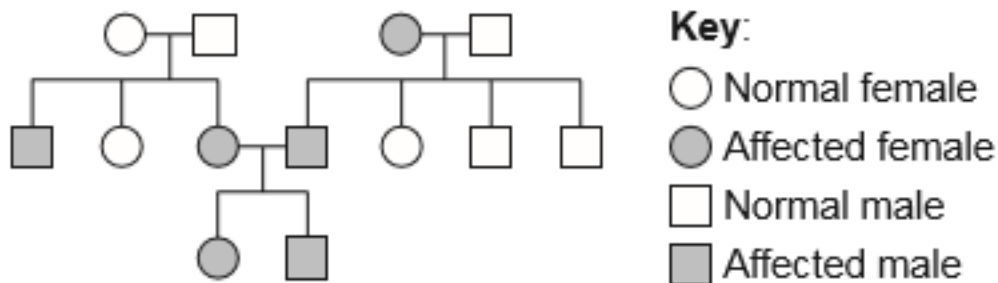
16. [1 mark]

What is produced by somatic-cell nuclear transfer?

- A. Adult sheep
- B. Cloned embryos
- C. Rooted stem-cuttings
- D. Genetically modified food

17. [1 mark]

The diagram shows a pedigree chart.



What does it reveal about the inheritance of the blood disorder beta-thalassaemia?

- A. The allele is autosomal recessive.
- B. The allele is autosomal dominant.
- C. The allele is sex-linked.
- D. The allele is co-dominant.

18. [1 mark]

Some of the ratios that Morgan investigated in genetic crosses did not correspond with expected Mendelian ratios. What was the cause?

- A. The genetic crosses used insects rather than plants.
- B. The results were counted more reliably than Mendel's.
- C. The genes in the genetic crosses were linked.
- D. *Drosophila* has more genes than plants.

19. [1 mark]

State an application of plasmids in biotechnology.

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20. [3 marks]

Reproduction in eukaryotes can be sexual or asexual.

Outline natural methods of cloning in some eukaryotes.

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21. [3 marks]

The growing human population has an increasing demand for energy derived from crop plants. At the same time, increasing droughts that are part of climate change make it difficult to grow crops in some parts of the world.

Suggest possible benefits **and** risks of using genetic modification to develop varieties of crop plant with traits such as drought resistance.

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22. [5 marks]

Describe how DNA profiling can be used to establish paternity.

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23. [4 marks]

Cellular processes at the molecular level are regulated by enzymes.
Outline the process of DNA profiling.

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24. [7 marks]

More than 8 million different species are alive today but over the course of evolution, more than 4 billion may have existed.
Discuss the process, including potential risks and benefits, of using bacteria to genetically modify plant crop species.

25. [8 marks]

15

26a. [4 marks]

DNA research, involving biotechnology, has led to benefits for society but has given rise to some controversy.

Describe the polymerase chain reaction (PCR), including the role of Taq DNA polymerase.

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26b. *[8 marks]*

Explain benefits and risks of using genetically modified crops for the environment and also for human health.

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1. [1 mark]

B

2. [1 mark]

C

3. [1 mark]

A

4. [1 mark]

D

5. [1 mark]

D

6. [1 mark]

C

7. [1 mark]

B

8. [1 mark]

B

9. [1 mark]

D

10. [1 mark]

A

11. [1 mark]

D

12. [1 mark]

C

13. [1 mark]

B

14. [1 mark]

B

15. [1 mark]

D

16. [1 mark]

B

17. [1 mark]

A

18. [1 mark]

C

19. [1 mark]

transfer/vector of genetic material/genes/DNA fragments

OR

to produce insulin/useful protein

20. [3 marks]

Markscheme

a. clones are genetically identical organisms

OR

group of cells derived from a single parent cell

b. asexual reproduction in plants such as tubers/runners/bulbs

Allow other verifiable examples of plants

c. common in non-vertebrates such as budding in hydra

Allow other verifiable examples of invertebrates

d. budding in yeast/fungi

Allow other verifiable examples of fungi

e. identical twins «in humans» are clones because they originate from the same cell

21. [3 marks]

Markscheme

Benefits:

- a. increase crop growth/food productivity;
- b. with limited water/ less water is used;
- c. increase amount of land available for food production in dry areas;

Risks:

- d. these plants may out-compete other species in the community/may cause extinction of some species/affect the food chains in the community;
- e. the modified gene/recombinant DNA may pass to other organisms;
- f. more grain requires more nutrients from the soil so its quality may diminish/monoculture issues;
- g. GMO may have health effects in consumers / OWTTE;

Must include at least one benefit and one risk for [3 max].

22. [5 marks]

Markscheme

- a. DNA sample is collected from the child and its (potential) parents;
- b. from saliva/mouth swab/blood/other body cells;
- c. PCR used to amplify/produce more copies of the DNA;
- d. short tandem repeats/genes consisting of a repeating sequence of bases repeats copied/used;
- e. number of repeats varies between individuals;
- f. unlikely that two individuals have same number of repeats for every gene included;
- g. gel electrophoresis used to separate DNA fragments according to length/number of repeats;
- h. gel electrophoresis generates a unique pattern of bands
- i. DNA profile is the pattern of bands / diagram showing pattern of bands as in a DNA profile;
- j. all bands in the child's profile must be in one of the parents' profiles / OWTTE;

23. [4 marks]

Markscheme

- a. sample of DNA obtained from person/hair/blood/mouth/crime scene ✓
- b. PCR used to amplify/make copies of DNA (in sample) ✓
- c. using *Taq* DNA polymerase / using DNA polymerase from thermophilic bacteria ✓
- d. tandem repeats amplified/used ✓
- e. gel electrophoresis used to separate DNA (into bands) ✓
- f. separation according to length of fragments/number of repeats

OR

- fragments of same length/number of repeats travel same distance ✓
- g. pattern of bands/numbers of repeats is the profile/is unique to the individual ✓
- h. example of application/forensics/crime investigation/paternity ✓

Do not accept 'determine ancestry' for mph. Other genes/chromosomes are more often used for that.

Accept STR for (short) tandem repeat in mpd.

24. [7 marks]

Markscheme

Process:

- a. genetic modification by gene transfer between species;
- b. gene/Bt gene/DNA segment transferred from bacterium to plant/crop;
- c. gene/DNA codes for/responsible for desired protein/gene product;
- d. bacteria have/produce plasmids / gene/DNA inserted into plasmid;
- e. using restriction enzymes/endonucleases to cut DNA;
- f. using DNA ligase to join DNA;
- g. bacterium transfers (modified) plasmid to plant cell;

Benefits:

- h. increase crop yields / more food produced / less land needed to grow food;
- i. increase pest/disease resistance / use less pesticides/insecticides/fungicides;
- j. improves crops to be more nutritious/increased vitamin content;
- k. increased tolerance to saline soils/drought/high temperatures/low temperatures;

Risks:

- l. GM organisms could spread to sites (where they will cause harm);
- m. transferred gene could spread to other species / spread of herbicide resistance to weeds;
- n. GM crops that produce pesticide could kill non-pest insects/monarch butterflies / insect pests could develop resistance to pesticides/insecticides/Bt toxin;

25. [8 marks]

Markscheme

- a. genetic modification carried out by gene transfer between species
 - b. genes transferred from one organism to another produce the same protein/amino acid sequence
 - c. due to universality of genetic code
- OR**
- organisms use same codons of mRNA to code for specific amino acids
- d. mRNA for required gene extracted/identified
 - e. DNA copies of mRNA made using reverse transcriptase
 - f. PCR used (to amplify DNA to be transferred)
 - g. genes/DNA transferred from one species to another using a vector
 - h. plasmid acts as vector to transfer genes to bacteria/*E. coli*
 - i. plasmid cut open at specific base sequences using restriction endonuclease
- OR**
- plasmid cut to produce blunt ends then extra cytosine/C nucleotides added
- OR**
- sticky ends made by adding extra guanine/G nucleotides
- OR**
- mention of sticky ends if not gained already
- j. cut plasmids mixed with DNA copies stick together (due to complementary base pairing)

k. DNA ligase makes sugar-phosphate bonds to link nucleotides of gene with those of plasmid

l. bacteria that take up plasmid are identified

m. (genetically modified) bacteria will reproduce carrying the transferred gene

n. example – *eg:* as production of human insulin using *E. coli* bacteria

Accept any of the points clearly explained in an annotated diagram.

26a. [4 marks]

Markscheme

a. PCR is process by which a small sample of DNA can be amplified/copied many times

b. PCR involves repeated cycling through high and lower temperatures «to promote melting and annealing of DNA strands»

c. «mixture» is heated to high temperatures to break «hydrogen» bonds between strands of DNA/to separate the double-stranded DNA

d. Taq DNA polymerase can withstand high temperatures without denaturing

e. primers bind to «targeted» DNA sequences at lower temp

f. Taq DNA polymerase forms new «double-stranded» DNA by adding «complementary» bases/nucleotides

26b. [8 marks]

Markscheme

Environment benefits:

a. pest-resistant crops can be made

b. so less spraying of insecticides/pesticides

c. less fuel burned in management of crops

d. longer shelf-life for fruits and vegetables so less spoilage

e. greater quantity/shorter growing time/less land needed

f. increase variety of growing locations / can grow in threatened conditions

Environment risks:

g. non-target organisms can be affected

h. genes transferred to crop plants to make them herbicide resistant could spread to wild plants making super-weeds

i. GMOs (encourage monoculture which) reduces biodiversity

j. GM crops encourage overuse of herbicides

Health benefits:

k. nutritional value of food improved by increasing nutrient content

l. crops could be produced that lack toxins or allergens

m. crops could be produced to contain edible vaccines to provide natural disease resistance

Health risks:

n. proteins from transferred genes could be toxic or cause allergic reactions

o. antibiotic resistance genes used as markers during gene transfer could spread to «pathogenic» bacteria

p. transferred genes could cause unexpected/not anticipated problems

OR

health effects of exposure to GMO unclear

