# Answers

## Unit 1 DNA and the genome

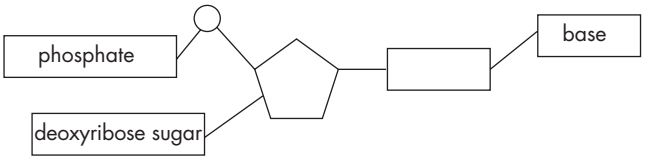
### 1 Structure of DNA

#### 1A Structure of DNA

1 The genotype is determined by the sequence of bases

2 Deoxyribose sugar, phosphate and base

3




4 Hydrogen bonds

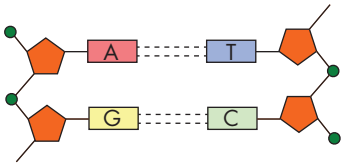
5 Double-stranded helix

6 Adenine, thymine, cytosine, guanine

7 **a** Base pairing (adenine–thymine and guanine–cytosine)

**b** Two strands running in opposite directions

8 Structure of DNA:




9 FALSE – nucleotides

TRUE

FALSE – deoxyribose

10 genetic/DNA/genotype

#### 1B Organisation of DNA

1 Linear chromosomes

2 **a** E.g. any plant/animal/fungus

**b** E.g. bacteria/archaea

3 Mitochondria and chloroplast

4 Tightly coiled and packaged with associated proteins

5

| Cell characteristics | Prokaryote | Eukaryote |
|---|---|---|
| Contains nucleus | No | Yes |
| Chromosomal DNA | Circular | Linear (and circular within organelles [mitochondria and chloroplast]) |
| Plasmids in cytoplasm | Yes | No |

6 FALSE – circular

TRUE

FALSE – proteins

7 **a** P

**b** Circular chromosome

**c** Circular chromosomes

**d** Bacterium

**e** Chloroplast

8 D

9 A

#### 1C Short extended response question

- Circular chromosomal DNA and plasmids in prokaryotes
- Circular plasmids in yeast (eukaryotes)
- Circular chromosome in mitochondria and chloroplasts of eukaryotes
- DNA in the linear chromosomes in the nucleus of eukaryotes
- Is tightly coiled and packaged with associated proteins (eukaryotes)

[any 4]

#### 1D Longer extended response question

Nucleotides (deoxyribose sugar, phosphate and base)

- Bases are adenine, thymine, cytosine, guanine

- Sugar–phosphate backbone
- Complementary base pairing (adenine–thymine and guanine–cytosine)
- Hydrogen bonds (join complementary bases together)
- Double-stranded antiparallel structure
- With deoxyribose and phosphate at 3′ and 5′ ends of each strand respectively
- Forming a double helix

[any 7]

### 1E Key terms

1. J
2. I
3. H
4. F
5. C
6. A
7. B
8. E
9. D
10. G
11. P
12. M
13. N
14. O
15. K
16. L

### 1F Data handling and experimental design

1. **a i** Separation temperature

   **ii** Vessel containing DNA/distance from heat source/species from which DNA extracted/any other suitable

   **b** Each DNA section was only tested once/the investigation was not repeated for each A–T base pair number

   **c** Labels and scales correctly added; points plotted correctly and line drawn with ruler

   **d** The greater the number of A–T base pairs in a strand of DNA, the lower the separation temperature/or inverse

   **e** A–T base pairs only have two bonds, compared to three in G–C, so less heat energy, so lower temperature, is required to break the bonds

2. 140
3. D
4. D

## 2 Replication of DNA

### 2A Replication of DNA

1. Enzymes (DNA polymerase and ligase), DNA template strand, free nucleotide bases, primers, ATP
2. **a** Allows DNA polymerase to start replication

   **b** Adds complementary nucleotides to the deoxyribose (3′) end of a DNA strand

   **c** Joins fragments of DNA together
3. DNA polymerase can only add DNA nucleotides in one direction resulting in one strand being replicated continuously and the other strand replicated in fragments
4. So that ... an exact copy/complete set of ... genetic material/genetic instructions/genetic information/genes/DNA/chromosomes

   AND

   is passed to (each) ... new cell/daughter cell/the next generation OR during mitosis/cell division OR so new cells have the same ... genetic material/genetic instructions/genetic information/genes/DNA/chromosomes ... as the original cell OR to maintain the ... number of chromosomes/chromosome complement ... in new/daughter cells
5. The amplification of DNA *in vitro*
6. Forensics/paternity testing/any other suitable

7

| Temp. (°C) | Description of events |
|---|---|
| 90 | DNA heated to separate strands |
| 55 | Cooling allows primers to bind to target sequences |
| 72 | Heat-tolerant DNA polymerase replicates the region of DNA |

8 FALSE – DNA polymerase

TRUE

TRUE

9 **a** Adenine

**b** Hydrogen

**c** Allow DNA to tightly coil around it

**d** Allow DNA polymerase to start replication

**e** Ligase

10 A

11 B

12 D

13 C

14 C

15 B

16 replicated/primer/unwound/locations/nucleotides/continuously/fragments

### 2B Short extended response question

- DNA polymerase
- Adds complementary nucleotides to the deoxyribose (3′) end of a DNA strand
- Fragments of DNA are joined together
- By ligase
- Heat-tolerant DNA polymerase
- Replicates the region of DNA

[any 4]

### 2C Longer extended response question

1 **i** DNA replication

- DNA unwinds and unzips to form two template strands
- DNA polymerase needs a primer to start replication
- DNA polymerase adds complementary nucleotides to the deoxyribose (3′) end of a DNA strand
- Resulting in one strand being replicated continuously
- And the other strand replicated in fragments
- Fragments of DNA are joined together by ligase

**ii** amplification of DNA

- DNA heated to separate strands
- Cooling allows primers to bind to target sequences
- Primers are complementary to specific target sequences at the two ends of the region to be amplified
- Heat-tolerant DNA polymerase replicates the region of DNA
- Repeated cycles of heating and cooling amplify this region of DNA

[any 7]

### 2D Key terms

1 A

2 E

3 I

4 C

5 H

6 G

7 F

8 J

9 D

10 B

### 2E Data handling and experimental design

1 **a** **i** Average time for one cycle

**ii** Temperature (of the thermal cycler)

**b** Measured the time for 30 cycles, for each DNA polymerase, and calculated an average

**c** So it does not denature

**d** Taq DNA polymerase carries out PCR cycles faster than Pfu, KOD and Pwo

**e** To allow PCR to be carried out more efficiently/quickly/cheaply

**f** All variables the same (same contents) but without the enzyme

A negative control

## 3 Control of gene expression

### 3A Structure and function of RNA

1

| | DNA | RNA |
|---|---|---|
| Where found in the cell | nucleus/ plasmid/ mitochondria/ chloroplast | nucleus/ cytoplasm/ ribosome |
| Strands | two (double) | one (single) |
| Sugar in nucleotide | deoxyribose | ribose |
| Adenine paired to | thymine | uracil |

2

| | Location | Function |
|---|---|---|
| mRNA | nucleus/ ribosome | carries a copy of the DNA code from the nucleus to the ribosome |
| tRNA | cytoplasm/ ribosome | carries a specific amino acid |
| rRNA | ribosome | combines with proteins to form the ribosome |

3 D

### 3B Transcription

1 A process involving transcription and translation where DNA sequences are used to direct the production of proteins

2 RNA polymerase

3 Nucleus

4 Exons (coding) and introns (non-coding)

5 The introns of the primary transcript of mRNA are removed and the exons are joined together to form mature transcript

### 3C Translation

1 Ribosome

2 Anti-codon

3 Peptide

4 **a** tRNA

**b** X = amino acid attachment site, Z = anti-codon

**c** Hydrogen

**d** Carries a specific amino acid

### 3D One gene – many proteins

1 The order of the amino acids will determine shape and structure, as will peptide bonds, folded polypeptide chains, hydrogen bonds, and interactions between individual amino acids

2 **a** 2345 or 1345 or 1235

**b** Introns

3 FALSE – peptide

TRUE

FALSE – tRNA

FALSE – primary

FALSE – anti-codon

TRUE

4 C

5 C

6 structures/functions/peptide/fold/hydrogen/amino

### 3E Short extended response question

- RNA has a single strand while DNA has a double strand
- RNA replaces thymine with uracil
- RNA replaces deoxyribose with ribose sugar
- mRNA (messenger) carries a copy of the DNA code from the nucleus to the ribosome
- rRNA (ribosomal) and proteins form the ribosome

- Each tRNA (transfer) carries a specific amino acid

[any 4]

### 3F Longer extended response question

1 **i** transcription

- Occurs in nucleus
- RNA polymerase moves along DNA unwinding and unzipping the double helix
- RNA polymerase synthesises a primary transcript of RNA from free RNA nucleotides
- By complementary base pairing
- The introns of the primary transcript of mRNA are non-coding
- And are removed
- In RNA splicing
- The exons are coding regions
- And are joined together to form mature transcript

[any 7]

**ii** translation

- Occurs in ribosome
- tRNA folds due to base pairing to form a triplet anti-codon site and an attachment site for a specific amino acid
- Triplet codons on mRNA and anti-codons translate the genetic code into a sequence of amino acids
- Start and stop codons exist
- Codon recognition of incoming tRNA
- Peptide bonds join amino acids
- Exit of tRNA from the ribosome
- As polypeptide is formed

### 3G Key terms

1 S

2 L

3 N

4 V

5 E

6 M

7 U

8 Q

9 I

10 B

11 H

12 K

13 C

14 T

15 D

16 F

17 J

18 O

19 P

20 A

21 R

### 3H Data handling and experimental design

1 **a** Protein size

**b** Temperature in gel tank/pH of buffer solution/type of gel/current

**c** Protein sample only tested once

**d** Labels and scales correctly added; points plotted correctly and line drawn with ruler

**e** From the protein sample tested, the largest protein is myosin with all the others being significantly smaller

**f** To maintain the pH and ensure the result is valid due to control of this variable

## 4 Cellular differentiation

### 4A Cellular differentiation

1 Process by which a cell develops more specialised functions by expressing the genes characteristic for that type of cell

2 **a** Meristem

**b** Stem cell

3 (Adult) tissue e.g. bone marrow, liver, heart

4 Provides information on how cell processes such as cell growth/differentiation/gene regulation work

5 Repair of damaged or diseased organs or tissues or example such as corneal transplants and skin grafts for burns

6 TRUE

TRUE

FALSE – tissue

FALSE – meristems

7 **a** Differentiates into/specialises into/becomes ... many/lots of/all/wide range of cell types/tissue types OR it is pluripotent/totipotent

**b** Different proteins will be produced/synthesised/made (resulting in different cell types) OR only proteins characteristic of that cell type are produced/synthesised/made

8 meristems/unspecialised/stem/divide/differentiate

**4B Short extended response question**

1 **i** Ethical issues associated with the use of stem cells

- Destruction of the embryo
- Embryos which would have been destroyed are being put to good use
- Use of stem cells for drug testing rather than animals
- Possible cures for diseases
- Regulations on the use of embryonic stem cells
- The use of induced pluripotent stem cells
- The use of nuclear transfer techniques

[any 4]

**ii** Therapeutic and research uses of stem cells

- The repair of damaged or diseased organs or tissues
- Named example of therapeutic use
- Research provides information on how cell processes work
- Such as cell growth, differentiation and gene regulation
- Can be used as model cells
- To study how diseases develop or for drug testing

[any 4]

**4C Longer extended response question**

- Cellular differentiation is the process by which a cell develops more specialised functions by expressing the genes characteristic for that type of cell
- Stem cells are unspecialised somatic cells in animals that can divide to make copies of themselves (self-renew)
- And/or differentiate into specialised cells
- Cells in the very early embryo can differentiate into all the cell types that make up the organism (are pluripotent)
- These cells don't self-renew *in vivo*, but can under the right conditions in the lab
- It is then they are termed embryonic stem cells
- Are used as a source of stem cells in research
- Tissue (adult) stem cells are needed for growth, repair and renewal of tissues
- They replenish differentiated cells that need to be replaced and give rise to a more limited range of cell types (are multipotent)
- E.g. blood stem cells found in the bone marrow produce the various blood cell types or other named example
- Once a cell becomes differentiated it only expresses the genes that produce the proteins characteristic for that type of cell

[any 7]

**4D Key terms**

1 K

2 F

3 I

4 G

5 J

6 B

7 C

8 D

9 A

10 E

11 H

### 4E Data handling and experimental design

1 **a i** Growth medium

**ii** Temperature of the petri dish/volume/mass of growth media/pH of growth media/species/type of plant/light intensity

**b** Only three meristems cultured in each growth medium

**c** Labels and scales correctly added; points plotted correctly and line drawn with ruler

**d** 20

**e i** C

**ii** D

## 5 Structure of the genome

### 5A Structure of the genome

1 The entire hereditary information encoded in DNA of an organism

2 Coding and non-coding

3 Proteins

4 tRNA, rRNA and RNA fragments

5 D

6 A

### 5B Short extended response question

- The genome of an organism is its entire hereditary information encoded in DNA
- DNA sequences that code for protein are defined as genes
- The structure of the genome includes coding and non-coding sequences
- A genome is made up of genes and other DNA sequences that do not code for proteins
- Non-coding sequences include those that regulate transcription and those that are transcribed to RNA but are never translated
- Most of the eukaryotic genome consists of these non-coding sequences
- Non-translated forms of RNA include tRNA, rRNA and RNA fragments
- Some non-coding sequences have no known function

[any 4]

### 5C Key terms

1 D

2 A

3 B

4 C

## 6 Mutations

### 6A Single gene mutations

1 Changes in the genome that can result in no protein or an altered protein being expressed

2 Involve the alteration of a DNA nucleotide sequence as a result of the substitution, insertion or deletion of nucleotides

3 **a** One nucleotide is replaced by another

**b** One nucleotide is inserted into the sequence

**c** One nucleotide is removed from the sequence

4 **a** A = deletion, B = insertion, C = substitution

**b** 1 = major, 2 = major, 3 = minor

5 Insertion or deletion of nucleotides which results in every subsequent codon to the right of the mutation in the base sequence being different

6 Results in the synthesis of a different/non-functional/no protein

**7**

| Substitution mutation type | Change | End effect on protein produced |
|---|---|---|
| missense | one nucleotide base and then codon, is replaced with another | possible change in protein shape/function |
| nonsense | one codon is replaced with a stop codon | shortens the protein may become non-functional or its function will be changed |
| splice-site | change in nucleotide at a splice site (between intron and exon) | alter post-transcriptional processing |

**8** C

**9** A

**6B Chromosome structure mutations and the importance of mutations and gene duplication in evolution**

**1** Alterations to the structure of one or more chromosomes/can involve changes to chromosome number/structure

**2** **a** Genes are copied and remain in the chromosome

**b** Genes are rotated/flipped within the chromosome

**c** Gene removed from chromosome

**d** Genes from one chromosome are added on to another chromosome

**3** They are the only source of new/novel alleles which create variation

**4** Allows new genes to be produced while the original gene which was duplicated is retained, increasing variation

**6C Longer extended response question**

- (Single gene) mutations are random changes in DNA sequences/genes/alleles/the genome
- Single gene mutation name AND description:
  - o substitution – base/base pair/nucleotide is replaced/substituted by another
  - o insertion – base/base pair/nucleotide is added/inserted
  - o deletion – base/base pair/nucleotide is removed/deleted
- Insertion/deletion results in a frameshift mutation/expansion of a nucleic acid sequence
- (Single nucleotide) substitutions include missense, nonsense and splice-site mutations
- Splice-site mutations can alter the mature mRNA OR result in exon removal OR result in introns remaining present
- Chromosome mutation can involve changes to chromosome number/structure
- Chromosome mutation name AND description:
  - o translocation – genes/sections of chromosome from one chromosome become attached to another chromosome
  - o deletion – genes/sections of chromosome deleted from chromosome
  - o inversion – genes/sections of chromosome/rotate through 180°/flipped
  - o duplication – genes/sections of chromosome/pieces of chromosome are duplicated/repeated

[any 7]

**6D Key terms**

**1** I

**2** L

**3** F

**4** J

5 G

6 C

7 D

8 K

9 B

10 M

11 H

12 E

13 A

### 6E Data handling and experimental design

1 **a** A

**b** UV light intensity/temperature of culture dishes/media/species/type of yeast/any other suitable

**c** Experiment could be repeated for each yeast culture several times and an average calculated

**d** Labels and scales correctly added; points plotted correctly and line drawn with ruler

**e** Yeast culture A is more sensitive to the UV light than culture B/more colonies were present after 24 hours in yeast culture B than A/UV light inhibits/kills culture A quicker than B

## 7 Evolution

### 7A Evolution, gene transfer and selection

1 The changes in organisms over generations as a result of genomic variations

2 **a** From parent to offspring as a result of sexual or asexual reproduction

**b** Exchange of genetic material from one cell to another

3 Prokaryotes and viruses

4 The non-random increase in frequency of DNA sequences that increase survival and the non-random reduction in harmful sequences

5 **a** The extreme characteristics are selected against

**b** Favours an extreme characteristic away from the most common characteristics

**c** Favours two extreme characteristics at the expense of the most common characteristics

6 A

### 7B Speciation

1 A group of organisms capable of interbreeding and producing fertile offspring, and which does not normally breed with other groups

2 The generation of new biological species by evolution as a result of isolation, mutation and selection

3 Separate populations so they are unable to interbreed/prevent gene flow and may experience different selection pressures

4 Isolation barriers separate populations

Different mutations occur to each population

Some mutations are favourable

Different selection pressures on each population

Results in natural selection

After many generations, new species may form

Which are no longer able to interbreed with other populations to produce fertile offspring

5 Speciation due to a geographical isolation barrier

6 Mountain/river/forest/island/any other applicable

7 Speciation due to behavioural or ecological barriers

8 TRUE

FALSE – isolation

9 B

### 7C Shorter extended response question

1 natural selection

- Organisms show (genomic) variation (upon which natural selection acts)
- Natural selection is the non-random
- Increase in frequency of DNA sequences
- That increase survival
- (Survivors) pass on their favourable/ beneficial gene sequence/alleles/ characteristics to offspring/next generation
- And the non-random reduction in harmful sequences
- Sexual selection
- Is the non-random increase in frequency of DNA sequences that increase reproduction
- The differences in outcome as a result of
  - o Stabilising – favours the middle characteristics in variation
  - o Directional – favours an extreme characteristic away from the middle
  - o Disruptive selection – favours two extreme characteristics at the expense of the middle characteristics

### 7D Longer extended response question

1 **i**, **ii** Mentioned under either heading:

- Isolation prevents gene flow/ interbreeding
- Different mutations in each population
- Different selection pressures
- Natural selection occurs
- New species formed when two populations can no longer successfully interbreed

**i** allopatric speciation

- Geographical isolation barrier
- Example(s)

**ii** sympatric speciation

- Behavioural or reproductive isolation barrier
- Example(s)

[any 7]

### 7E Key terms

1 K

2 F

3 I

4 D

5 G

6 B

7 J

8 A

9 E

10 H

11 C

### 7F Data handling and experimental design

1 **a** **i** The number of days where two different species of bird were present in a hybrid zone

**ii** Hour of day observed/area of zone

**b** Only measured from January to June/only measured for 1 hour each day

**c** Measure all year round/more than 1 hour per day

**d** They may be migrating species, so not near the zone at that time of year

**e** **i** 200%

**ii** 5:4

**iii** 5

## 8 Genomic sequencing

### 8A Genomic sequencing

1 Process where the exact order of the nucleotide bases along an organism's genome is determined

2 Nucleotide base sequences can be determined for individual genes and entire genomes, allowing easier detection of mutations

3 **a** Bioinformatics

**b** Faster/cheaper to store/retrieve/analyse sequences

4 Study of evolutionary relatedness among groups of organisms

5 Sequence divergence is used to estimate time since lineages diverged using amino acid differences in genomes of related species

6 **a** **i** Phylogenetics

**ii** C and D

**b** **i** Evolutionary relatedness by looking at differences in nucleotide substitutions (in genome sequences) over time

**ii** sheep/goat

7 Fossil evidence and sequence data

8 Bacteria, archaea and eukaryotes

9 Many genes are highly conserved across different organisms

10 Sequencing, analysis and interpretation of the genome of an individual

11 Study of inherited genetic differences in drug metabolic pathways which can affect individual responses to drugs, both in terms of therapeutic and adverse effects

12 Distinguishing between neutral and harmful mutations in both genes and regulatory sequences, and in understanding the complex nature of many diseases

13 **a** Common ancestor

**b** Bear and chimpanzee

**c** Last common ancestor (of bears and lizards) was more recent (than bears and newts) OR lizards diverged more recently from bears than from newts

14 TRUE

FALSE – <u>sequence</u>

FALSE – <u>highly</u>

TRUE

15 C

16 B

17 A

**8B Short extended response question**

- Analysis of an individual's genome
- May lead to personalised medicine
- Through knowledge of the genetic component of risk of disease
- And likelihood of success of a particular treatment
- Difficulties in distinguishing between neutral and harmful mutations in both genes and regulatory sequences
- And in understanding the complex nature of many diseases

[any 4]

**8C Longer extended response question**

- Phylogenetics is the study of evolutionary relatedness among groups of organisms
- Molecular clocks help calculate sequence divergence, estimating time since lineages diverged
- Using (amino acid sequence) differences in genomes of related species
- Evidence from phylogenetics and molecular clocks
- To determine the main sequence of events in evolution
- Last universal ancestor, prokaryotes, photosynthesis, eukaryotes, multicellular organisms
- The sequence of events can be determined using sequence data
- And fossil evidence
- The use of sequence data to study the evolutionary relatedness among groups of organisms
- Sequence divergence is used to estimate time since lineages diverged
- Comparison of sequences provides evidence of the three domains
- Bacteria, archaea and eukaryotes

[any 7]

### 8D Key terms

1. E
2. F
3. N
4. I
5. B
6. M
7. L
8. K
9. A
10. G
11. D
12. H
13. C
14. J

### 8E Data handling and experimental design

1. **a** As estimated gene number increases, estimated genome size increases

   **b** 300%

   **c** 250:1

   **d** 1625

   **e** The fruit fly has a greater proportion of its genome as non-coding, whereas the plant has more coding sequences on its genome

# Unit 2 Metabolism and survival

## 9 Metabolism and survival

### 9A Introduction to metabolic pathways

1. All the chemical reactions which take place within a living organism
2. metabolic/enzymes/control/integrating
3. Anabolism involves substrates which are usually large, giving products which are usually small, whereas catabolism involves substrates which are usually small, giving products which are usually large

   Anabolism involves the release of energy whereas catabolism involves the use of energy
4. A = anabolic (energy is released),
   B = catabolic (energy is required)
5. A
6. Reversibility
7. The modified glucose is effectively trapped inside and cannot diffuse back out of the cell
8. In respiring tissue cells, the carbon dioxide concentration rises and is converted to the form which can be transported in the plasma, until this reaches the lung tissues where the carbon dioxide concentration is low. Here the same enzyme catalyses the reverse reaction to reform the carbon dioxide for elimination through the alveolar walls into the lungs
9. The glucose is metabolised much quicker to provide a rapid source of energy if required by the brain cells
10. **a** X – proteins

    Y – phospholipids

    Z – channel protein

    **b** Allows relatively large molecules to pass through

    **c** Y

    **d** Z
11. B
12. Change one substance into another/ increase reaction rate/lower activation energy

**Hint** Enzymes embedded in cell membranes perform similar functions to those elsewhere in the cell.

## 9B Control of metabolic pathways

1. When present enzyme allows a reaction to proceed

   When absent the reaction is prevented from proceeding

2. TRUE

   FALSE – absent

3. **a** Induced fit

   **b** X – substrate

   Y – active site

   Z – products

   **c** Stage 1 substrate approaching active site of enzyme

   Stage 2 active site induced to change shape/orientation of the active site to fit the substrate

   Stage 3 products being formed

   Stage 4 products released

   **d** Stages 1, 2 and 3 have high affinities

   Stage 4 has a low affinity

4. **a** Activation

   **b** Lowers the energy input/activation energy

5. **a** Energy levels of products are higher than the reactants

   **b** Energy levels in both cases are the same

6. D

7. D

8. **a** Competitive inhibition

   **b** Increasing the substrate concentration increases the rate of the reaction in the presence of the inhibitor

## 9C Short extended response question

- Mechanism allows control of a metabolic pathway which involves many enzymes
- Since many enzyme-catalysed reactions are reversible this mechanism is one way of making such reactions go in a particular rate and direction
- Product of the last reaction in the pathway inhibits the enzyme which catalyses the first reaction
- Product binds to a site, other than the active site, of the enzyme changing the shape of the active site
- Attachment of first substrate to first enzyme is now inhibited and reactions slows down or stops
- When supply of final product is in short supply the binding of the product to the first enzyme no longer occurs
- Active site restored to its function and reaction proceeds

[any 4]

## 9D Longer extended response question

- Metabolic pathway is a series of reactions which takes place in a living cell
- Two types are anabolic and catabolic
- Anabolic pathways result in the synthesis of large and complex molecules (products)
- From small and simple molecules (substrates)
- Energy is required to carry out anabolism supplied by the breakdown of ATP
- Example: synthesis of proteins from amino acids
- Catabolic pathways result in the breakdown of large and complex molecules (substrates)
- Into small and simple molecules (products)
- Energy is released and used to synthesise ATP
- Example: breakdown of starch to glucose

[any 7]

## 9E Key terms

1. M
2. L
3. K
4. J
5. B

6 C

7 A

8 I

9 H

10 G

11 E

12 F

13 D

14 O

15 N

### 9F Data handling and experimental design

1 **a** 5.0

**b** 8

**c** At a concentration of 20% the rate of conversion no longer increases

**d** Total number of substrate molecules converted into products (unit volume/unit time)

2 C

3 **a** 0.6 g/hour

**b** 45 g/100 $cm^3$

**c** 40–50 hours

**d** 30

## 10 Cellular respiration

### 10A Breakdown of glucose

1 glucose/water/oxygen/ATP/hydrogen/dehydrogenase/carrier/FAD/NAD

### 10B Role of ATP

1 **a** Glucose

**b** Protein synthesis/active transport/mitosis/muscle cell contraction/growth/biosynthesis

2 Phosphorylation

### 10C Metabolic pathways of cellular respiration

1 A

2 D

3

| Letter(s) | | |
|---|---|---|
| A | B | D |
| B | C | |
| A | D | |

4 oxygen/two/investment/phosphorylated/intermediate/ATP/pay-off/four

5 C

6 **a** X – glycolysis

Y – citric acid cycle

**b** V – carbon dioxide

W – citric acid

Z – oxaloacetate

**c** Remove hydrogen ions and electrons

**d** Matrix of mitochondrion

**e** Electron transport chain/cytochrome system

**f** Undergoes fermentation to lactate

7 NAD

8 Fermented to ethanol and carbon dioxide

9 FALSE – <u>inner</u>

TRUE

### 10D ATP synthesis

1 ions/chain/matrix/mitochondria/ATP/synthase/rotate/aerobic

2 C

### 10E Short extended response question

- ATP synthase is an enzyme which synthesises ATP
- Enzyme is located in the membrane of the mitochondrion
- Energy to drive the synthesis of ATP comes from a flow of hydrogen ions across the membrane

- Through a channel in the enzyme
- Down a concentration gradient
- As hydrogen ions pass through ATP synthase channel part of the enzyme rotates, generating ATP

[any 4]

### 10F Longer extended response question

- Takes place in cytoplasm
- Does not require oxygen
- Each step is controlled by an enzyme
- Glucose is broken down to pyruvate
- Two ATP molecules are used up
- As energy investment phase
- Provides energy to phosphorylate glucose
- Reactions which follow generate four ATP molecules
- As energy pay-off phase
- With net gain of two ATP molecules
- Hydrogen ions are removed from the intermediates
- By dehydrogenase enzyme
- Then picked up by NAD to form NADH

[any 7]

### 10G Key terms

1. M
2. N
3. G
4. F
5. D
6. E
7. C
8. I
9. O
10. L
11. J
12. A
13. B
14. K
15. H

### 10H Data handling and experimental design

1. **a** Draw suitable graph making values easy to read; include 0/0 for each axis but don't extrapolate the line back to the origin, starting first plot at 5 on the *x*-axis

> **Hint** When plotting graphs, don't include a plot for the zero value if you don't have data for this.

**b** 10 g/kg muscle

**c** Glycogen is not the only energy source for respiring muscles

**d** 20%

**e** 12:25:32

**f** Average endurance time (mins)

**g** Volunteers of different ages/sexes/fitness levels/dietary habits

**h** Sample size small/not enough replicates of the investigation

## 11 Metabolic rate

### 11A Measurement of metabolic rate

1. FALSE – <u>used</u>

   TRUE
2. A

### 11B Transporting oxygen to cells

1. A
2. A – fish

   B – amphibian

   C – reptile
3. one/one/one/gills/heart/reptiles/ventricle/twice/circuit/double/pressure

   mammals/atria/ventricles/high

### 11C Short extended response question

- Relates to surface–volume ratio
- Smaller mammals have more surface area relative to their volume
- Than large mammals which have less surface area relative to their volume
- Since the mammals exchange heat with their environment across their body surfaces
- Small mammals lose heat much quicker than large mammals in the same environmental temperature
- Thus a small mammal respires quicker than a large mammal to generate heat to maintain its body temperature

[any 4]

### 11D Longer extended response question

- Transport of oxygen to all living cells is vital for aerobic respiration.
- Larger organisms, such as amphibians and reptiles, have a high demand for oxygen.
- Such organisms have evolved an efficient circulatory system
- Heart has one ventricle and two atria
- Blood flows through heart twice for each circuit of the body
- Separation of blood low in oxygen from that which is high in oxygen is not complete
- Some mixing occurs in the ventricle
- Ventricle has ridges that help direct the blood low in oxygen away from that rich in oxygen
- Deoxygenated blood is sent to the lungs
- Oxygenated blood is sent to the body tissues
- Double circuit of blood helps maintain pressure inside blood vessels

[any 7]

### 11E Data handling and experimental design

1 **a** 500 $cm^3$

**b** 15

**c** 2400 $cm^3$

**d** 2500 $cm^3$

**e** 6000 $cm^3$

**f** 0.4 seconds

**g** Only one person was used

## 12 Metabolism in conformers and regulators

### 12A Effect of external factors

1 **a** Temperature/salinity/pH

**b** Metabolism is controlled by enzymes

Any factor which affects enzyme activity will affect an organism's metabolic rate

The factor has to be within a relatively narrow range to allow the organism's metabolism to function optimally

2 B

### 12B Conformers and regulators

1 Conformer is an organism which cannot maintain its internal metabolic rate in a changing environment

Regulator is an organism which can maintain its internal metabolic rate in a changing environment

2 B

3 FALSE – more

TRUE

TRUE

FALSE – wide

4 C

5 Conformers occupy narrow ecological niches

Regulators occupy a wide range of ecological niches

6 The maintenance of a steady internal environment independent of the external environment

7 Regulation requires energy to maintain the body temperature and pH at a suitable level for enzymes to work optimally

### 12C Negative feedback control and thermoregulation in mammals

1 variables/narrow/set point/negative feedback/regulators/environment/temperature/receptors/nervous/hypothalamus/brain/effectors/skin/set point

2 B

3 1 set point
2 change above or below set point
3 receptors detect change above or below set point
4 change is communicated to effectors
5 effectors react to reverse the change
6 return to set point

4 D

5 A

6 Hypothalamus

### 12D Short extended response question

- Metabolic reactions are catalysed by enzymes which are temperature sensitive
- Homeostasis preserves body temperature as near to the set point as possible
- This allows enzymes to function at their optimum efficiency
- Many substances pass into/out of cells by diffusion
- Increasing temperature increases the rate of diffusion
- By causing the molecules to move faster

[any 4 but include 2 from enzyme function and diffusion]

### 12E Longer extended response question

- As body temperature increases the hypothalamus detects the change:
  - Effectors such as sweat glands become more active releasing sweat
  - And blood vessels near the skin dilate
  - Reducing body temperature
  - Picked up by the hypothalamus by a negative feedback to reverse these responses
  - Body temperature returns to set point
- As body temperature decreases the effectors react in the opposite way
  - Negative feedback causes sweat secretion to decrease and blood vessels near the skin to constrict
  - Shivering helps generate heat by involuntary muscle contractions
  - These conserve heat
  - Body temperature returns to set point

[any 7 but include 3 from each]

### 12F Key terms

1 F

2 G

3 A

4 C

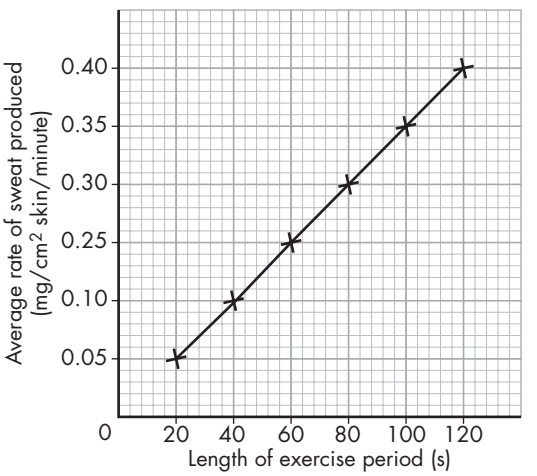
5 D

6 E

7 B

### 12G Data handling and experimental design

1 **a**




**b** Humidity of the room/air movement in room/rate/speed/intensity of walking/ settings on treadmill kept constant for each trial/volume of water taken in/type of clothing/technique for measuring mass of sweat produced/level of fitness of people

**c** Repeat the procedure with more people/ use different sexes

**d** Allow rate of sweat production to return to normal level

**e** 0.80 mg

**f** 0.40–0.45 mg [any value between including lowest and highest]

**g** Average rate of sweat production

## 13 Metabolism and adverse conditions

### 13A Surviving adverse conditions

1. habitat/temperature/limits/tolerate/slow down/fatal/conserve/metabolic/adaptations/homeostasis
2. A
3. D
4. Advantage:

   Organism remains active longer and is able to make greater use of available resources

   Disadvantage:

   Organism may be exposed to potentially serious environmental conditions before it can take the necessary precautions to survive
5. FALSE – hibernation

   FALSE – aestivation

   TRUE

### 13B Avoiding adverse conditions

1. Tern can exploit new habitats to obtain food/suitable climatic conditions not available at certain times of the year in a habitat which has become inhospitable
2. D
3. B
4. Genes

### 13C Short extended response question

- Predictive dormancy:
  - Organism goes into a dormant condition before the adverse conditions begin
  - Usually found in environments where changes occur predictably
  - Typical cue would be changes in day length
- Consequential dormancy
  - Organism goes into a dormant condition after the adverse conditions begin
  - Usually found when conditions can change unpredictably
  - Typical cue would be sudden change in climate

[any 4 but 2 from each]

### 13D Longer extended response question

- Migration is a regular behaviour pattern
- Can occur over short or long distances
- Up/down mountains or vertically through columns of water
- Involves change in habitat
- Allows animal to exploit alternative and favourable resources
- Ringing:
  - Well-established technique for following movement of birds over long distances
  - Uses aluminium bands carrying basic information wrapped around bird's leg
- Tagging:
  - Alternative to ringing
  - Uses dyes and/or plastic tags
  - Useful for migratory behaviour in mammals and insects
- Radar:
  - Modern radar is very powerful and can plot height, airspeed and rate of wing beat
  - Animals include bats and birds
  - Aquatic equivalent is sonar
  - Can track movement of shoals of fish
- Radio transmitter:
  - Modern electronics allows even small animals to have an electronic transmitter fitted
  - Follows animal's position in space over long distances
  - Dependent on power of transmitter and receiver
- Global tracking:
  - Uses orbital satellite tracking
  - Animals can be fitted with transmitter which sends back information to a global positioning system
  - Many different kinds of data can be collected
  - May be solar powered

- Light-level monitoring:
  - Possible to fit an animal with electronic sensor sensitive to light intensity
  - Animal has to be recaptured to recover these data and remove the sensor
  - Useful for animals which spend a lot of time underwater where they cannot be easily tracked by satellites

[any 7 but must include 3 points from migration]

### 13E Key terms

1. G
2. H
3. I
4. F
5. E
6. D
7. C
8. J
9. B
10. K
11. A

### 13F Data handling and experimental design

1. **a** Group 1 A
   Group 2 C
   Group 3 B
   Group 4 E
   Group 5 D
   **b** Group E
   **c** Group 1
   **d** Groups C and D
   **e** Groups A, B and C
2. **a** Heartbeat rises from 20 bpm to 300 bpm
   **b** 900%
   **c** Between 2000 and 2200

## 14 Environmental control of metabolism

### 14A Growing microorganisms

1.

| Feature | Bacteria | Archaea | Eukaryota |
|---|---|---|---|
| Nucleus present | No | No | Yes |
| Organelles present | No | No | Yes |
| Chromo-some shape | Circular | Circular | Linear |
| Number of cells | Unicellular | Unicellular | Unicellular and multi-cellular |

2. D
3. adaptable/variety/substrates/metabolism/species/niches/substrates/industry/adaptable/culture/manipulation/products
4. Temperature/pH/nutrients/oxygen level
5. Light or chemical
6. FALSE – light
   TRUE
   FALSE – many
7. A – solid
   B – liquid/broth
8. Vitamins and fatty acids
9. To prevent contamination of the culture and to prevent the culture contaminating the environment
10. To maintain pH at a constant level
11. B
12. **a** pH and temperature
    **b** To maintain the temperature inside the fermenter/to prevent the loss of heat from the fermenter
    **c** Keeps the microorganisms, nutrients and temperature evenly distributed
    **d** To prevent contamination of the culture

### 14B Phases of microbial growth

1. **a** A lag
   **b** log/exponential

**c** stationary

**d** death

**b**

| Phase | Description |
|---|---|
| **A** | high rate of metabolism and new enzymes being produced |
| **B** | number of microorganisms increases exponentially |
| **C** | number of microorganisms produced equals number dying |
| **D** | microorganisms starved of nutrients/accumulate toxins and die |

**c** Use of buffer/addition of acid or alkali

**d** Generation

2 B

3 A

4 Use a counting slide to record only those cells which are not stained and are therefore still alive/viable

### 14C Short extended response question

- Changing the conditions to enhance growth
- Suitable pH using buffer
- Suitable temperature using incubator
- Precise medium using precisely prepared culture media
- Ensuring plentiful supply of oxygen by not fully sealing Petri dishes

[any 4]

### 14D Longer extended response question

- Four distinct phases
- Lag phase:
  - Little change in numbers of cells
  - Metabolic activity is high
  - Cells adjust to growth medium
  - New enzymes induced
- Exponential phase:
  - Cells numbers increase at a constant geometric rate
  - So long as nutrients are plentiful
  - And conditions are suitable for growth
- Stationary phase:
  - Nutrients start to become depleted
  - Toxins build up
  - pH changes
  - Number of cells being produced balanced by number dying
  - Secondary metabolites often produced
- Death phase:
  - Cells starved of nutrients
  - Killed off by increased toxin levels

[any 7 but include all four phases]

### 14E Key terms

1 K

2 D

3 I

4 A

5 J

6 F

7 C

8 E

9 B

10 M

11 L

12 H

13 G

### 14F Data handling and experimental design

1 **a** $1.59 \times 10^5$

**b** Plate E

**c** Take more samples from the original culture

2 20 minutes

3 4

## 15 Genetic control of metabolism

### 15A Improving wild strains of microorganisms

1. strains/synthesise/useful/yeasts/ethanol/sugar/map/genetically/biofuel/ethanol/toxic/ethanol

2. TRUE
   TRUE

3. Mutagenesis
   Recombinant DNA technology

4. D

5. Large cell size makes it easier to remove the cells from the growth medium

6. B

### 15B Recombinant DNA technology

1. TRUE
   TRUE

2. Plasmid/virus/piece of artificial chromosome

3. **a** Restriction site

   **b** DNA cutting enzyme – restriction endonuclease

   Enzyme which joins/binds DNA strands together – DNA ligase

   **c** The exposed base sequence can easily match up with a complementary sequence from the DNA from another source

4. **a** Plants are grown on a medium containing the antibiotic

   Only the cells which have taken up the desired gene and the gene conferring antibiotic resistance will grow

   **b** Marker gene

5. restriction/double/different/difficult/desired/restriction/double/two/restriction site/sticky end/restriction/plasmid/sticky end/complements/plasmid

6. Artificial chromosome can carry many more genes than a virus or plasmid

### 15C Short extended response question

- Yeast are useful organisms for use as vectors in DNA recombinant technology
- Can be transformed to produce useful proteins normally synthesised by human cells
- Proteins formed by recombinant bacteria do not undergo post-translational modification
- Such proteins do not fold properly
- Cannot form the correct 3-dimensional structure of the protein to allow it to function

[any 4]

### 15D Longer extended response question

Mutagenesis

- Uses agents such as ultra-violet radiation and mustard gas
- Cause changes in the DNA of microorganism
- Affected cells may then produce an altered form of a metabolite which is useful to humans
- Affected cells may be an improvement on wild form
- Can be cultured up for industrial use
- Technology now allows specific sites of the DNA to be targeted

[any 4]

**Hint** A well-labelled diagram would be a suitable alternative here.

### 15E Key terms

1. B
2. C
3. A
4. E
5. F
6. D
7. G
8. K

9 J

10 H

11 I

### 15F Data handling and experimental design

1 **a** 0.3 g/100 $cm^3$

**b** 40–50 hours

Hint Always remember to include units.

**c** 50%

**d** 18:25:30

**e** Time (hours)

## Unit 3 Sustainability and interdependence

### 16 Food supply and photosynthesis

#### 16A Food supply

1 The ability of human populations to access food of sufficient quality and quantity

2 increasing/population/rise/supply/import/staple/maize/decreases/increases/high

3 B

4 FALSE – increase

FALSE – increase/enhance

TRUE

FALSE – more

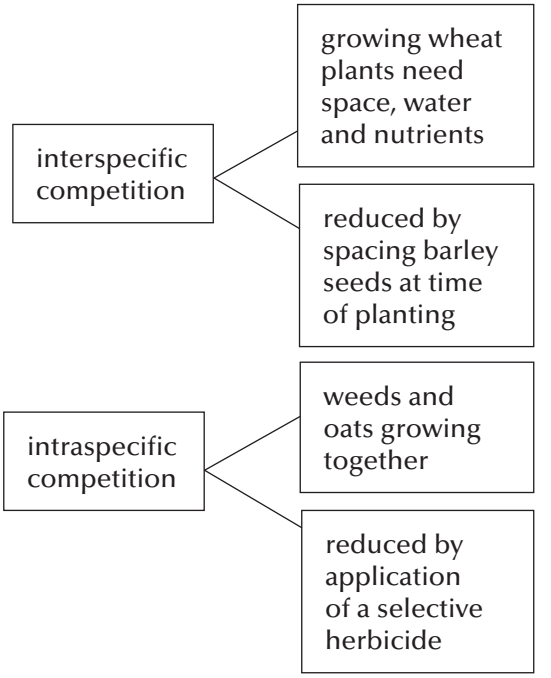
5 Cultivar

6 **a** Growth requires proteins which are made up of nitrogen-containing amino acids/many of the molecules associated with growth metabolism, such as enzymes, contain nitrogen

**b** Expensive

May cause environmental damage/algal blooms if excess leaches out into water supplies

7




8 Domesticated livestock are herbivores

Occupy the second feeding level in food chains

Only 10% of energy from plant food is actually built into animal tissue

Most of the energy is lost as heat

Energy loss in growing plants is significantly less

9 Goats may be reared on sparse areas/in harsh environments unsuitable for crop production

#### 16B Photosynthesis

1 B

2 White light consists of a range of wavelengths (colours) which are absorbed by the leaf pigments

Except for green light which is reflected into the eye

3 TRUE

FALSE – extend

4 **a** Chlorophyll a/b

**b** Graph for increasing rate of photosynthesis does not follow that of increasing absorption/photosynthetic rate rises in yellow region even when absorption is low

**c** Allows plant to absorb light/colours/ energy from more regions of the spectrum

**5** Carotenoids extend the range of wavelengths absorbed/pass energy to chlorophyll

**6** A

**7** chloroplasts/absorbed/split/hydrogen/ photolysis/stomata/hydrogen/coenzyme/ NADP/NADPH/electrons/pigments/ chloroplasts/electron transport chain/ synthase

**8** TRUE

TRUE

FALSE – ATP

**9** A 7

B 4

C 3

D 2

E 8

F 6

G 1

H 5

**10** A

**11** In bright light water molecules are split into hydrogen and oxygen

Process called photolysis

Hydrogen is picked up by dye thereby reducing it

Causing dye to change from blue to colourless

**12**

| Compound | Description |
|---|---|
| 3-phosphoglycerate | precursor of glyceraldehyde-3-phosphate |
| RuBisCO | attaches carbon dioxide to RuBP |
| 3-phosphoglycerate | first stable compound formed after carbon dioxide enters the cycle |
| G3P | used to regenerate RuBP |

**13** **a** Glucose

**b** Stored in cell as starch

Used for respiration

Used to synthesise cellulose for plant cell walls

Form new metabolites within other metabolic pathways

**14** B

**16C Short extended response question**

- Food security is the ability of human populations to access food of sufficient quality and quantity
- At all times and be able to afford to buy it
- Increase in human population and concern for food security leads to a demand for increased food production
- Food production must be sustainable
- Also, must not degrade the natural resources on which agriculture depends
- Closely linked to readily available supply of clean drinking water

[any 4]

**16D Longer extended response question**

- Stage which does not require light energy
- Takes place in central area of chloroplasts
- Glucose is produced
- Enzymes involved at every stage
- Carbon dioxide passes out of leaf by diffusion
- RuBisCo attaches carbon dioxide to RuBP
- RuBP converted to 3-phosphoglycerate
- 3-phosphoglycerate phosphorylated to G3P using ATP combined with hydrogen from NADPH
- Some G3P regenerates RuBP
- Some G3P used to make glucose

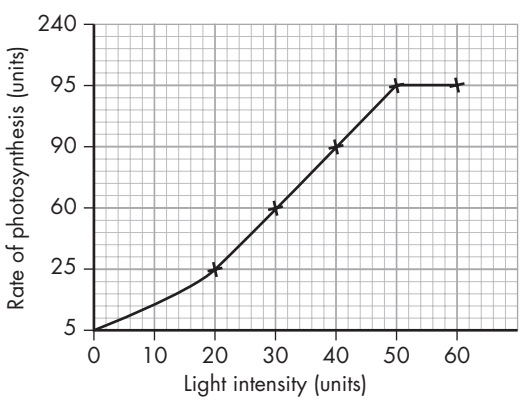
[any 7]

### 16E Key terms

1. M
2. L
3. K
4. J
5. I
6. H
7. N
8. G
9. B
10. C
11. D
12. E
13. A
14. F

### 16F Data handling and experimental design

1. **a**




**b** 95 units

**c** Light intensity

2. B
3. 10 000 kJ/m$^2$/year

## 17 Plant and animal breeding

### 17A Plant and animal breeding

1. traits/phenotypes/productivity/genes/genotypes/phenotypes/breeding/specific/cultivar
2.

| Livestock | Crops |
|---|---|
| disease resistance | resistance to pests and diseases |
| higher food yields | higher nutritional value |
| ability to survive in harsh environments | ability to grow in poor soils |

3. B
4. High chance of two closely related individuals both carrying a harmful recessive allele for the trait
5. Produces animals/plants with desirable specific traits/establishes desirable trait over many generations/efficient and viable method of farming
6. D

### 17B Plant field trials

1. TRUE

   FALSE – <u>can</u>
2. **a** Soil type/variety of plant/spacing of seeds/any other suitable

   **b** Keep all variables the same but with no application of the selective herbicide
3. D

### 17C Inbreeding

1. FALSE – <u>outbreeding</u>

   TRUE

   TRUE
2. B

3 In a small population, matings between close relatives are much more likely than in a large population

4 **a** X = inbreeding

**b** Introduce adders from other populations

### 17D Cross breeding and $F_1$ hybrids

1 cross/parents/alleles/gene/monohybrid/single/cross/parent/dominant/offspring/generation/gene/cross/breeding/population/characteristics

2 Maximise yield/create a relatively uniform heterozygous crop

3 $F_2$ is genetically highly variable

### 17E Genetic technology

1 polymerase chain reaction/genome sequencing/desirable/identified/breeding/transformation/genome/breeding programmes

### 17F Short extended response question

- Breeding genetically similar individuals
- May result in an increased frequency of recessive, harmful heterozygous recessive alleles
- Heterozygous traits gradually removed
- When selecting for a desirable phenotype
- Can be avoided by adding new individuals to maintain genetic diversity
- Self-pollinating plants are naturally inbreeding
- Less susceptible to inbreeding depression

[any 4]

### 17G Longer extended response question

- Some phenotypes in food crops and animals are desirable
- Phenotypes may be inheritable
- These can be selected for by farmers and growers
- Ensures their genes are conserved for use in future breeding programmes
- Individuals with desirable phenotypes are used
- Examples in animals include disease resistance/high rate of reproduction/good rate of plant conversion to muscle tissue/ability to survive in extreme conditions/high level of nutritional value [give 1 example]
- Examples in plants include disease resistance/good economic yield/good conversion of light energy into glucose and carbohydrate/ability to grow in poor soils/high level of nutritional value [give 1 example]
- Using only those individuals with the desirable phenotype cultivars can be sustained
- As a result of genome sequencing, organisms with desirable genes can be identified and then used in breeding programmes
- Using genetic transformation techniques, a single gene can be inserted into a genome which can then be used in breeding programmes

[any 7]

### 17H Key terms

1 B

2 D

3 C

4 A

5 E

6 H

7 F

8 G

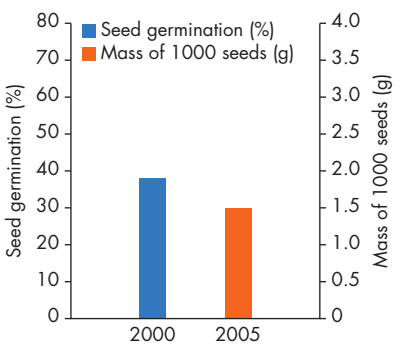
## 17I Data handling and experimental design

**1 a**

| Cultivar | Seed germination (%) | | | Mass of 1000 seeds (g) | | | Seed moisture content (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Year when seeds were produced | | | | | | | | |
| | 2000 | 2005 | Average | 2000 | 2005 | Average | 2000 | 2005 | Average |
| 1 | 60 | 70 | 65 | 1.5 | **1.0** | 1.25 | 8.0 | 7.6 | **7.8** |
| 2 | **56** | 70 | 63 | 1.3 | 1.5 | 1.40 | 7.5 | 7.9 | 7.7 |
| 3 | 10 | 66 | 38 | 1.6 | 1.4 | 1.50 | 6.8 | 7.0 | **6.9** |
| 4 | 74 | 80 | 77 | 2.0 | 2.2 | 2.10 | 7.2 | 7.0 | 7.1 |
| 5 | 45 | **55** | 50 | 2.2 | **2.0** | 2.10 | 8.0 | 7.6 | 7.8 |

**b** Year

**c**




**d** Sample size was large

**e** 13:10

**f** 3

**2 a** Oats

**b** 122.4 tonnes

## 18 Crop protection

### 18A Weeds

**1** Large areas of farmland are dedicated to a single plant type/bare ground which create(s) ideal environment for weeds to grow

**2** Protect soil from erosion/replace organic material/absorb soluble nutrients which might otherwise leach away/absorb carbon dioxide from atmosphere/help conserve biodiversity/provide habitat for insects and other animals

**3** Light/nutrients/water/soil nutrients/carbon dioxide/space

**4** FALSE – quickly

FALSE – annual

TRUE

FALSE – able

**5 a** Perennial – can resist environmental stress and remain dormant

**b** Systemic – to penetrate the taproot/killing upper part of plant only would be ineffective at control

**c** Chemical weedkiller may kill other species of plants/may not break down in soil for long time/may leach into nearby waterways/may enter food chains and bioaccumulate

**d** Seeds are very light so easily blown by wind long distances away from parent plant/reduces competition for same resources as parent plant/large numbers ensure that many survive to germinate

**6** C

**7** FALSE – invertebrates

TRUE

**8** Nematode worms/insects/molluscs/spiders

**9** A

### 18B Control of weeds pests and diseases by cultural means

**1 a** ploughing/autumn sowing/weeding/crop rotation

**b** ploughing - breaks down roots of perennial weeds and helps clear the planting area of any previous crops which might host pests and/or diseases

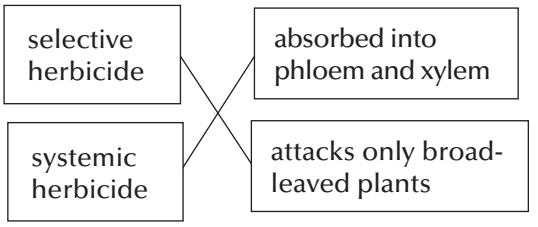
autumn sowing - allows seeds to germinate before pest populations develop in spring

weeding - mechanical removal of weeds between rows of crops helps keep them at an acceptable level

crop rotation - planting different crops in each field every year breaks the life cycle of any pests which might be present from a previous year

**18C Control of weeds, pests and diseases by chemical means**

1




2 pests/bacteria/insects/toxic/species/specific/target/persistent/degrade/bioaccumulate/fungicides/inhibit/fungicides/systemic/more

3 B

**18D Biological control and integrated pest management**

1 **a** Biological control

**b** Attract insects, including natural predator of pest/provide alternative food for pests

**c** Benefits can be used on crops which are resistant to pesticides

there is no residue of any chemical

no damage to the environment due to drifting chemical spray/bioaccumulation/other species affected

Limitations is not effective against all pests

does not eliminate pest only controls the numbers at an acceptable level

some crop damage/loss inevitable

control itself could become a pest eventually

2 C

3 TRUE

FALSE – primary

TRUE

**18E Short extended response question**

- Ploughing and weeding:
  - Physical removed of weeds manually or using machines
  - Tractor-led ploughs can turn over soil between rows of crops
  - Breaks up weeds above and below soil
  - Repeated to avoid regrowth of weeds
- Crop rotation:
  - Growing four different crops in one field
  - Over 4-year period
  - Breaks life cycle of weeds
  - Helps stop nutrient loss

[any 4 but 2 from each]

**18F Longer extended response question**

- Broad-based approach of combining different pest-control strategies
- These include cultural, chemical and biological
- Aim is to reduce pest population below an acceptable economic level
- Data on pest species life cycle are collected
- Approach, based on economics, devised to expose humans and environment to minimum risks
- Pest numbers monitored over period of time
- When numbers exceed an acceptable threshold, a pest-management scheme is put in place
- Chemical treatments are a last resort
- Examples of chemicals
- Physical removal of pests may be practical to avoid and/or minimise use of chemicals
- Appropriate combinations of measures with minimal use of chemical pesticides

- Only infected plants are sprayed with chemical pesticide
- Careful matching of management of the application techniques to the crop, pest and pesticide is important
- Use of low-dosage spray equipment reduces overall pesticide use
- Biological control uses predator/parasite of pest
- Example

[any 7]

### 18G Key terms

1 B

2 A

3 E

4 F

5 C

6 D

7 I

8 G

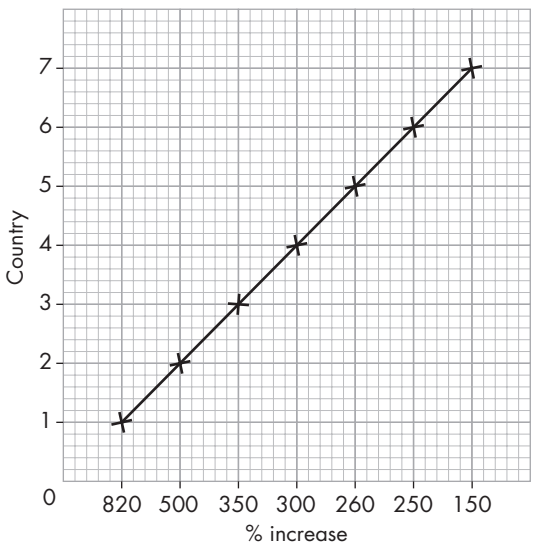
9 J

10 K

11 H

### 18H Data handling and experimental design

1 **a**




**b** % increase in use of pesticides

**c** 6:7:10

**Hint** Remember to preserve the order asked in the question.

2 **a** Disease maize

Weeds millet

**b** Rye

**c** 4:11:5

**d** Rice

Millet

## 19 Animal welfare

### 19A Livestock production

1 animals are less stressed and this leads to a higher rate of reproduction and productivity.

2 TRUE

TRUE

FALSE – <u>can</u>

3 B

4 misdirected/abnormal/feathers/tails/hyper-aggression/reduced

### 19B Observing animal behaviour

1 1 B

2 C

3 E

4 D

2 An investigation set up to give data on two or more different experimental conditions

Animal has equal choice of any condition

Different conditions could include availability of water, food, bedding, space

Data collected could include frequency of entering/time spent in a particular environment/range of activities

Data can be used to improve animal welfare

### 19C Short extended response question

- Occurs when animals are kept in cramped conditions/conditions which are barren/deprived of social contact

- Animals show repetitive and purposeless behaviours
- Example: pigs confined to restrictive metal crates
- Chewing on crate bars

  OR

  Large cats in small enclosures
- Pacing up and down

[Any 4 but only 1 example and associated behaviour]

**19D Longer extended response question**

- Animals must be free from discomfort
- Have ready access to food, water, space, proper housing
- Motivation is a main drive of animals
- To finding access to food, water, air, mate
- And best living environment
- When there are no needs animal is not motivated
- Motivation will be high when a need arises
- Can be measured experimentally
- Preference testing can be used
- Example: different floorings for barn-raised hens

[any 7 but must include suitable example]

**19E Key terms**

1. I
2. A
3. E
4. F
5. G
6. B
7. D
8. C
9. H
10. K
11. J

**19F Data handling and experimental design**

1. **a** 8%

   **b** Grooming

   **c** Observation
2. **a** Eating – 165

   **b** 80

   **c** Ensure monkey cannot see/detect observer

   **d** Only one monkey observed

   Use many similar monkeys in similar environments

## 20 Symbiosis

**20A Symbiosis**

1. **a** Co-evolved intimate relationships between members of two different species

   **b** Parasitism and mutualism

**20B Parasitic relationships**

1. **a** Symbiotic relationship where one organism benefits in terms of energy or nutrients, whereas its host is harmed by the loss of these resources

   **b** Any appropriate – tapeworms, fleas, barnacles, etc.
2. **a** Direct contact

   **b** Vector

   **c** Resistant stages
3. They often have limited metabolism and cannot survive out of contact with a host

**20C Mutualism**

1. **a** Symbiotic relationship where both species benefit

   **b** Any appropriate – the cellulose-digesting protozoa/bacteria in the guts of many herbivores or the photosynthetic algae in the polyps of coral, etc.

2 **a** Mitochondria and chloroplasts evolved from two different small prokaryotic cells that merged with a larger cell

**b** The smaller cells, the mitochondria and the chloroplasts, benefited by gaining security and the larger cell benefited from improved energy output (aerobic respiration) and food from photosynthesis

3 TRUE

FALSE – gains

TRUE

**20D Longer extended response question**

- Symbiosis relationship/association between two different species
- Co-evolution/co-evolved
- Parasites gain energy/resources/nutrients
- Host is harmed by/made weaker by these losses OR one benefits and the other is harmed
- Parasites can have limited metabolism
- Often cannot survive outside host/ reproduction requires host OR obligate
- Transmission/transfer method to new host or vector e.g. direct contact/ resistant stage
- Secondary hosts as vector
- E.g. of parasite and host
- Mutualism involves benefit for both species
- Interdependent relationship OR one cannot live without the other
- Example of mutualism
- Benefits to one described
- Benefits to other described

[any 7]

**20E Key terms**

1 F

2 E

3 A

4 H

5 C

6 I

7 G

8 J

9 B

10 D

**20F Data handling and experimental design**

1 **a i** Temperature

**ii** Species of parasite/same incubator/ when observed each day

**b** Place in incubator/oven

**c** 100 eggs were used for each temperature

**d** Labels and scales correctly added; points plotted correctly and line drawn with ruler

**e** 37 °C is the optimal temperature for parasite egg hatching/37 °C has the highest rate of parasite egg hatching compared to 5 °C and 60 °C/temperature has an effect on hatching rate

## 21 Social behaviour

**21A Social hierarchy**

1 **a** System where the members of a social group are organised into a graded order of rank

**b** Dominant and subordinate

**c** Pecking order in chickens or dominance hierarchy (e.g. alpha males/subordinates in many primates)

**21B Altruism and kin selection and its influence on survival**

1 **a** Behaviour that harms the donor individual but benefits the recipient

**b** Common between a donor and a recipient if they are related (kin)

2 Where the roles of donor and recipient later reverse, often occurs in social animals, e.g. vampire bats regurgitating blood or any other appropriate

3 **a** Altruism among animals that are closely related

**b** The donor will benefit in terms of the increased chances of survival of shared genes in the recipient's offspring or future offspring

**21C Social insects, the structure of their society and their importance**

1 Reproductive, soldiers and workers

2 Bees, wasps, ants and termites or any other appropriate

3 Queens and drones contribute reproductively

4 Co-operate with close relatives to raise relatives

**21D Primate behaviour**

1 Allows learning of complex social behaviour

2 **a** Ritualistic display and appeasement behaviour

**b** Grooming, facial expression, body posture and sexual presentation or any other appropriate, such as chest beating, raised tail, etc.

3 **a** Forming alliances

**b** Increased access to food/mates/territory or any other appropriate

4 TRUE

FALSE – sterile

5 parental/complex/conflict/appeasement/grooming/alliances/social

**21E Short extended response question**

- Have a social hierarchy which is a rank order OR has dominant/alpha AND subordinates
- Long period with parents/of parental care allows learning of complex behaviour/skills OR social behaviour/skills
- Ritualistic display AND appeasement behaviour occur
- Ritualistic/appeasement behaviour/display or correct example reduces conflict/tension/aggression
- Form alliances/grooming to raise social status/rank
- Behaviour influenced by ecological niche OR resource distribution OR taxonomic group

[any 4]

**21F Longer extended response question**

- Co-operative hunting is where animals hunt in a group/together
- Increases hunting success
- Allows larger prey to be brought down
- More successful than hunting individually
- (Subordinate) animals all get more food/energy ... than hunting alone
- Less energy used/lost per individual
- Social defence involves organisms staying close together as a group or in formation
- Increases survival chances for individuals
- Each individual in group spends less time/energy looking out for predators
- Warning signals to others in group

[any 7]

**21G Key terms**

1 L

2 K

3 H

4 J

5 I

6 D

7 C

8 E

9 A

10 B

11 G

12 F

### 21H Data handling and experimental design

1. D
2. C
3. **a** 63

   **b** 7:4

   **c** 100%

   **d** Shows teeth

   **e** **i** A

   **ii** B

   **iii** A

## 22 Components of biodiversity

### 22A Measuring biodiversity

1. Genetic, species and ecosystem diversity
2. Decrease in overall biodiversity even though individual species may become more numerous
3. The genetic variation represented by the number and frequency of all the alleles in a population
4. Species richness and relative abundance
5. A lower species diversity than one with the same species richness but no particularly dominant species
6. The number of distinct ecosystems within a defined area
7. FALSE – <u>lower</u>

### 22B Longer extended response question

- Measurable components of biodiversity include genetic diversity, species diversity and ecosystem diversity
- If one population dies out then the species may have lost some of its genetic diversity
- And this may limit its ability to adapt to changing conditions
- Genetic diversity comprises the genetic variation represented by the number and frequency of all the alleles in a population
- Species diversity comprises the number of different species in an ecosystem (the species richness)
- And the proportion of each species in the ecosystem (the relative abundance)
- A community with a dominant species has a lower species diversity than one with the same species richness but no particularly dominant species
- Isolated habitat islands have reduced biodiversity
- Smaller habitat islands have reduced biodiversity/or inverse
- Ecosystem diversity refers to the number of distinct ecosystems within a defined area

[any 7]

### 22C Key terms

1. A
2. C
3. E
4. B
5. D

### 22D Data handling and experimental design

1. A
2. C
3. **a** **i** Habitat island area

   **ii** Same 12-hour period in the day/same month/season/time of year

   **b** As the area of habitat island increases, the species richness increases

   **c** Repeat the observation of each area several times

   **d** Labels and scales correctly added; points plotted correctly and line drawn with a ruler

   **e** As the area of habitat island increases the species <u>diversity</u> increases

   **f** They all have different areas

   **g** Measure species richness per $m^2$

**h** 150%

**i** 1:5

**j** 34

## 23 Threats to biodiversity

### 23A Exploitation and recovery of populations and the impact on their genetic diversity

1. Overhunting, overfishing, deforestation
2. Reduction with some unable to recover as they lose the genetic variation necessary to enable evolutionary responses to environmental change
3. Bottleneck effect
4. Causes inbreeding which results in poor reproductive rates
5. Any acceptable, e.g. cheetahs

   Despite naturally low genetic variation they remain viable

### 23B Habitat loss, habitat fragments and their impact on species richness

1. Habitat loss due to deforestation, desertification, construction, or any other appropriate
2. Division of a larger habitat into smaller ones
3. As the habitat size decreases, the species adapted to the habitat edges (edge species) may invade the habitat at the expense of interior species
4. **a** Habitat corridor which provides a path to join fragments together

   **b** Allows species to move between habitat fragments and feed, mate and recolonise habitats after local extinctions

### 23C Introduced, naturalised and invasive species and their impact on indigenous populations

1. **a** Species that humans have moved either intentionally or accidentally to new geographic locations

   **b** Species that become established within wild communities

   **c** Naturalised species that spread rapidly and eliminate native species
2. Free of predators, parasites, pathogens and competitors
3. May prey on native species, out-compete them for resources or hybridise with them
4. FALSE – <u>small</u>

   FALSE – <u>decreasing</u>

   FALSE – <u>low</u>
5. rapidly/native/predators/competitors/prey/resources/hybridise

### 23D Short extended response question

- Habitat fragments suffer from degradation at their edges
- This may further reduce their size
- Species adapted to the habitat edges (edge species) may invade the habitat at the expense of interior species
- To remedy widespread habitat fragmentation, isolated fragments can be linked with habitat corridors
- Allowing species to move between habitat fragments
- Feed, mate and recolonise habitats after local extinctions

[any 4]

### 23E Longer extended response question

- Introduced (non-native) species are those that humans have moved either intentionally or accidentally to new geographic locations
- Those that become established within wild communities are termed naturalised species
- Invasive species are naturalised species that spread rapidly
- And eliminate native species
- Invasive species may well be free of the predators, parasites, pathogens and competitors

- That limit their population in their native habitat
- They may prey on native species
- Out-compete them for resources
- Or hybridise with them

[any 7]

### 23F Key terms

1. G
2. K
3. I
4. H
5. F
6. C
7. B
8. J
9. D
10. E
11. A

### 23G Data handling and experimental design

1. C
2. **a** Geographical areas

   **b** Ensure observation carried out at same time of year/month/season/area observed is the same/or any other appropriate

   **c** Observe at each area several more times and average the results

   **d** 50%