# B6 Inheritance, Variation and Evolution

***Write a definition for each key term***

| | |
|---|---|
| Cell | |
| Nucleus | |
| Chromosome | |
| DNA | |
| Gene | |
| Amino acid | |
| Protein | |
| Recessive | |
| Dominant | |
| Allele | |
| Punnet square | |
| Homozygous | |
| Heterozygous | |
| Phenotype | |
| Genotype | |
| Variation | |
| Genetic variation | |
| Environmental variation | |

Evaluate the use of the Human Genome Project in medical treatment

Use the table to help you plan your answer

| Advantages | Disadvantages |
| --- | --- |
| | |

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Describe what is meant by the term speciation

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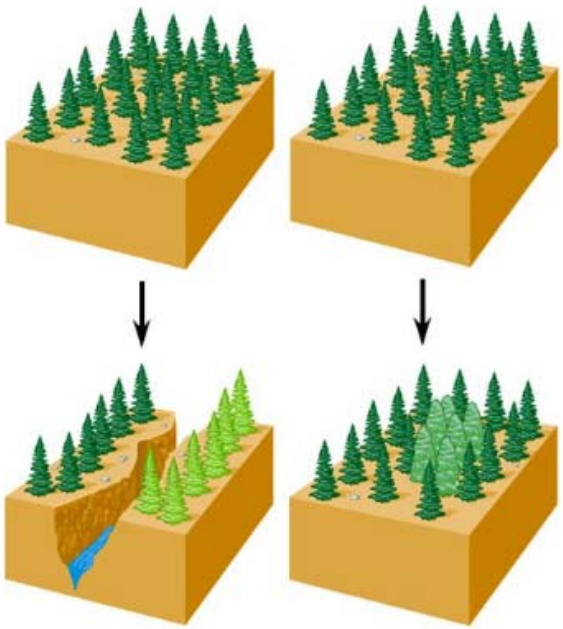

(HINT!)

**Figure 2** shows two species of ground squirrel, **W** and **X**.

**Figure 2**

**Squirrel W**

**Squirrel X**

Squirrel **W** lives on the high ground to the south of the Grand Canyon.

Squirrel **X** lives on the high ground to the north of the Grand Canyon.

The land to the north of the Grand Canyon is about 300 metres higher than the land on the south side. The north side also has lower winter temperatures and has more rain and snow than the south side.

(i) The two species of squirrel are very similar.

Describe **one** way, which you can see in **Figure 2**, in which squirrel **X** is different from squirrel **W**.

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**(1)**

(ii) The Grand Canyon was formed about 6 million years ago.

Explain how the two different species of squirrel could have developed from a common ancestor.

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**(6)**

(iii) Squirrels **W** and **X** are separate species, but they are still very similar.

Suggest why the two species have **not** become more different over time.

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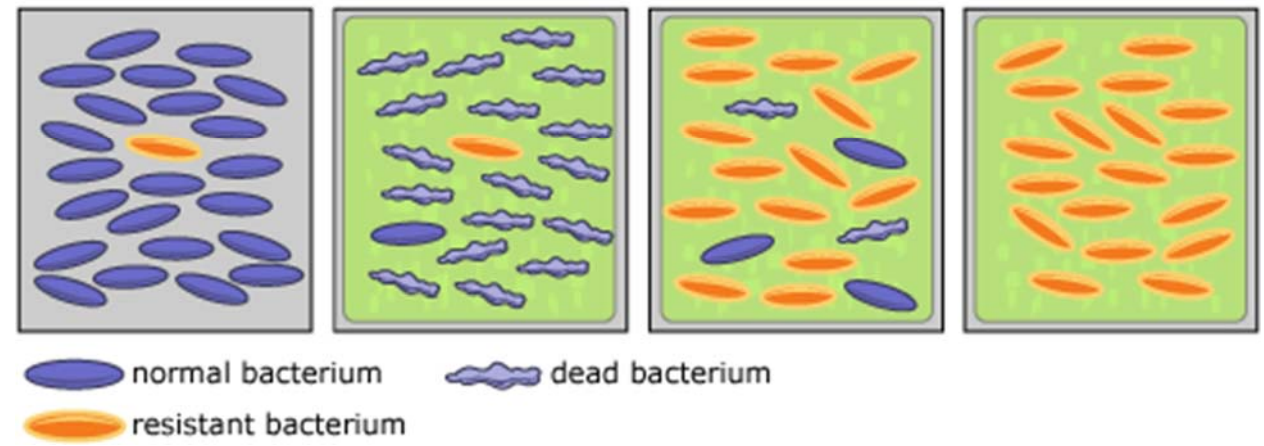
**(2)**

## Resistant Bacteria



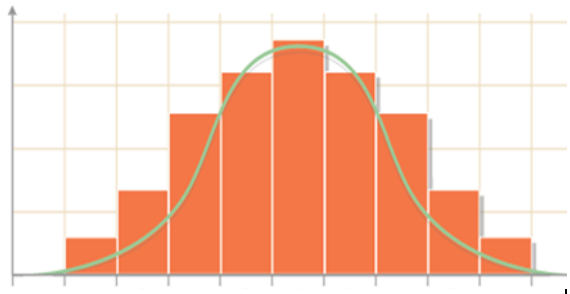
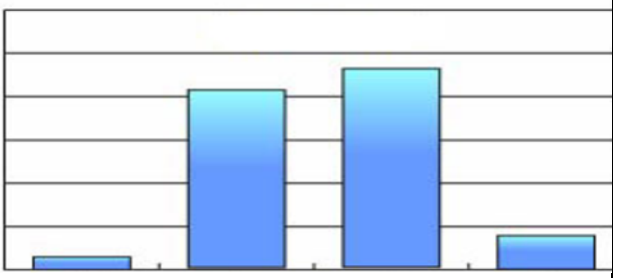

Use the diagram to help you explain how bacteria can become resistant to antibiotics

_____
_____
_____
_____
_____
_____
_____

What precautions can be taken to prevent the development of resistant strains?

1)_____ 2)_____

**Connect:** One of the graphs below shows continuous variation and the other shows discontinuous variation. Sort the different variables in the box under continuous or discontinuous.

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td><u>Continuous:</u> (the individuals vary within a range; measurable)<br>•<br>•<br>•<br>•</td><td><u>Discontinous</u> (Distinct categories; countable)<br>•<br>•<br>•<br>•</td></tr>
<tr><td colspan="2">Blood type, height, weight, eye colour, leaf length, number of offspring, GCSE grade, exact age</td></tr>
</table>

The graph showing continuous variation always has a _____. Where the _____ is in the middle and the curve is symmetrical about the _____.

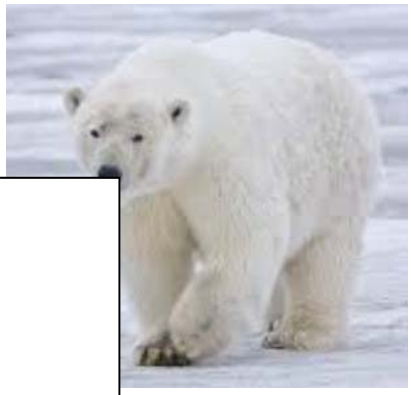
**Q: Where can genetic variation come from?**

1.
2.
3.

**Adaptations**: Special characteristics in an organism that help it survive in a specific environment.

**White fur:**

**Thick fur:**



**Wide feet:**

**Layer of blubber:**

**Evolution:** Evolution is the slow and continuous change of organisms from one generation to the next. Natural selection is Charles Darwin's theory which explains how this happens.

**To explain natural selection you need to remember the following:**

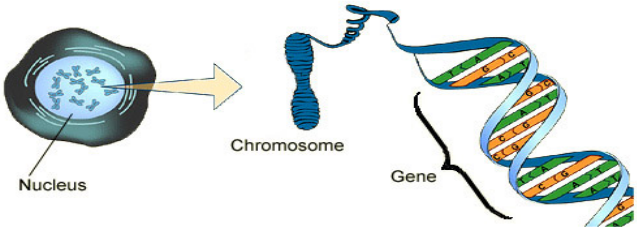
1. **Variation** - there is variation in characteristics of organisms
2. **Overproduction** – most organisms give birth to more young than can survive.
3. **Competition** – populations compete for resources e.g. Food, water
4. **Survival of the fittest** – those best adapted to the environment will survive.
5. **Reproduction** - the individuals which survive reproduce and pass on their genes.
6. Over time the proportion of individuals with beneficial characteristics will increase and the poorly adapted characteristic may be lost (this part is evolution).

**Evolution of the giraffe neck:** apply the steps above to the evolution of the giraffe neck.

| | |
|---|---|
| What is the variation between individuals? | *Giraffes vary in…* |
| Describe overproduction | *Most giraffes…* |
| What are they competing for? | *Giraffe offspring compete…* |
| Which ones survive and which ones die? | |
| Who can reproduce now? | *Only the…* |

| | |
|---|---|
| What happens over a long period of time? | |

## DNA, Genes, Chromosomes & The Nucleus




A gene is short section made of _____. Many genes together end to end make a _____.
Each **body cell** contains _____ of chromosomes.
A **sperm** or **egg cell** contains _____ chromosomes.

## Important definitions:

**Allele:**

**Genotype:**

**Phenotype:**

**Homozygous:**

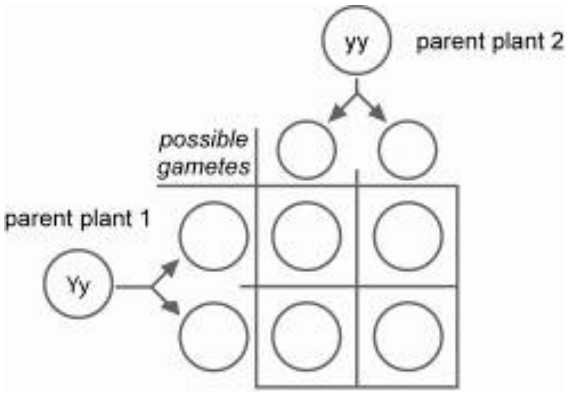
**Heterozygous:**

**Punnet square diagrams:** These can be used to predict the percentage of offspring that can inherit a certain characteristic from their parents.

The allele for yellow peas (Y) is dominant. The allele for green peas (y) is recessive.

**a** Complete the Punnett square.

**b** What is the genotype of parent plant 2?




**c** Out of every four offspring, how many are likely to have the yellow phenotype?

**d** Which parent plant is heterozygous for this characteristic?

## Genetic diseases:

There are many types of rat snake in the world.

The table below shows two types of rat snake.

| |  © Kazzpix/iStock/Thinkstock |  © Talkir/iStock/Thinkstock |
|---|---|---|
| **Type of snake** | Japanese rat snake | Texas rat snake |
| **Colour of snake** | Green | Pale brown |
| **Type of environment** | Grass | Dry and dusty |

The different types of rat snake have evolved from similar ancestors.

The rat snakes have evolved to to suit their environments.

Explain how the Japanese rat snake evolved to be different from the Texas rat snake.

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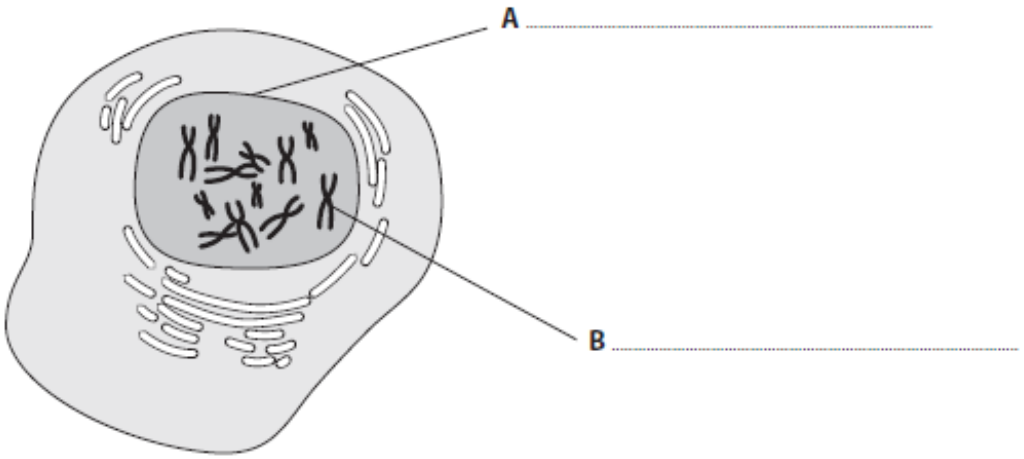
**(4)**

## Inheritance

**3** (a) The diagram shows a human body cell.

Name the structures labelled **A** and **B**.

(2)




(b) Genes code for the characteristics of an individual.

Different forms of the same gene are called alleles.

(i) Complete the sentence by putting a cross (☒) in the box next to your answer.

The term used to describe an individual with two identical alleles is

(1)

- ☐ **A** heterozygous
- ☐ **B** homozygous
- ☐ **C** dominant
- ☐ **D** recessive

(ii) Blue eyes are an example of a person's physical characteristics.

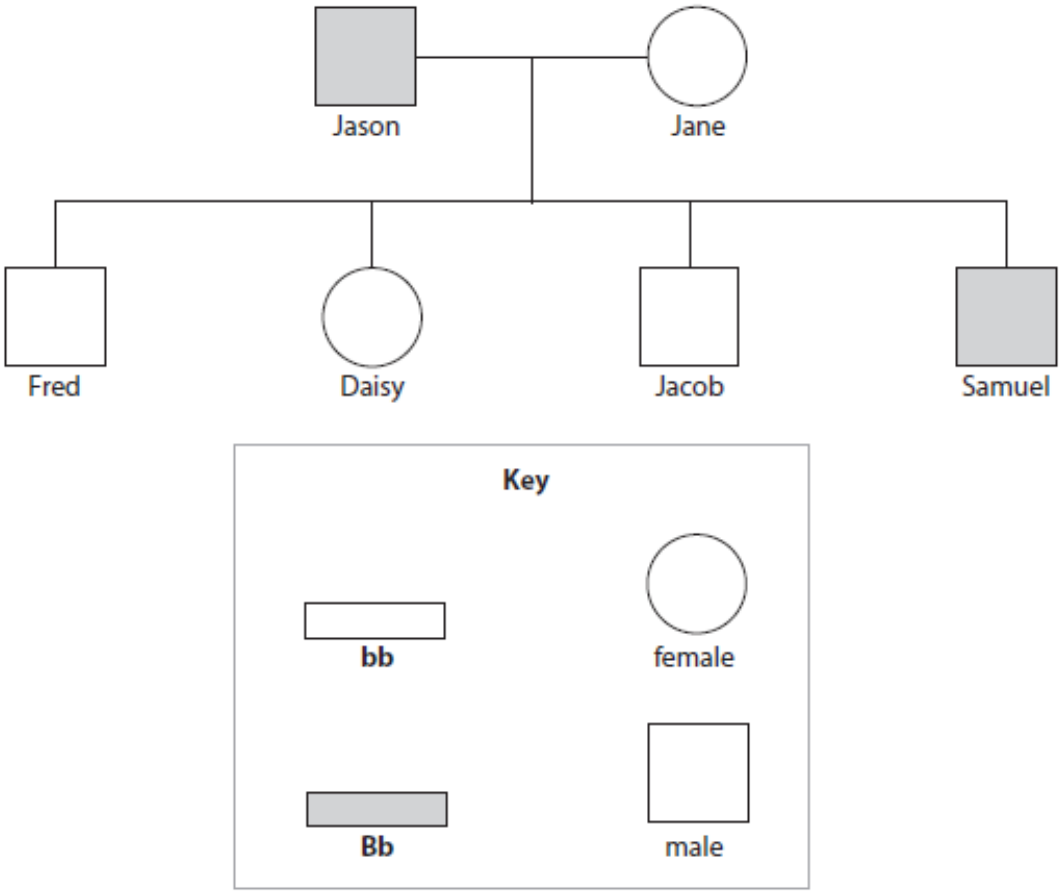
State the genetic term for a person's physical characteristics.

(1)

.....

(c) The diagram shows the inheritance of eye colour in a family.

The allele for brown eyes is **B** and the allele for blue eyes is **b**.




(i) How many offspring have blue eyes?

Put a cross (☒) in the box next to your answer.

(1)

☐ **A** 1

☐ **B** 2

☐ **C** 3

☐ **D** 4

(ii) Explain why none of the children of Jason and Jane have the genotype **BB**.

**(2)**

(iii) Fred has an identical twin.

Explain which of the other children is Fred's identical twin.

**(3)**

**(Total for Question 3 = 10 marks)**

## Inheritance of eye colour

**2** Jane has blue eyes and Keith has brown eyes.

They have a daughter Sue who has blue eyes.

The allele for brown eyes is dominant over the allele for blue eyes.

(a) (i) Complete the sentence by putting a cross (☒) in the box next to your answer.

Sue has the genotype

(1)

☐ **A** BB

☐ **B** Bb

☐ **C** bB

☐ **D** bb

(ii) Keith has the genotype Bb.

State the genetic term used to describe an individual with two different alleles for the same gene.

(1)

.....

(iii) Complete the Punnett square for Jane and Keith.

(1)

| | | Keith's gametes | |
|---|---|---|---|
| | | **B** | **b** |
| Jane's gametes | **b** | | |
| | **b** | | |

(i) **X** has white tail / shorter tail

*allow other points eg **X** has furrier tail / smaller feet / is furrier*

***or***

***W** has sharper claws / **W** has larger claws*

**1**

(ii) two (ancestral) populations separated / isolated (by geographical barrier / by canyon / river)

**1**

genetic variation (in each population) / different alleles / different genotypes / (different) mutation(s)

**1**

different environmental conditions / example described

*allow abiotic or biotic example*

**1**

the better adapted survive / natural selection occurs

*allow survival of the fittest*
*ignore they adapt to the environment*

**1**

so (different / favourable) alleles / genes passed on (in each population)

**1**

eventually two types cannot interbreed successfully

*allow to produce fertile offspring*

**1**

(iii) any **two** from:

- environments similar / described

  *allow example, e.g. similar predator(s) / food / climate*
- therefore similar adaptations / features / phenotypes suit

  *accept suitable named feature*
- original ancestor already well adapted

  *ignore reference to not enough time for evolution.*

**2**

(c) **Level 3 (3–4 marks):**
A detailed and coherent explanation is provided. Logical links between clearly identified, relevant points explain how the rat snake evolved through the process of natural
selection.

**Level 2 (1–2 marks):**
Simple statements made, but not precisely. The logic is unclear.

**0 marks:**
No relevant content.

**Indicative content**

**statements:**
- there are lots of different colours of snakes
- some shades of green are closer to the colour of the environment (in Japan) than others
- survivors (in each generation) will breed and produce offspring

**explanations:**
- different colours are controlled by different genes / alleles / are caused by mutations
- being green means they are best suited to grassy / green environments
- being green means they are camouflaged
- those that are camouflaged best will be able to catch more food
- those that are camouflaged best will be able to avoid being eaten
- survivors' offspring will inherit the genes / alleles / mutation for the shade of green colouration

**additional examiner guidance:**
- allow converse points relating to the Texas rat snake if they clearly identify the
  reasons why this snake was at an evolutionary disadvantage, ie more likely to be caught and eaten by a predator
- a good level 2 answer will clearly link survival and breeding to the passing on of the advantageous genes / alleles / mutations and link the idea of colour (AO2) to a
  correct explanation of its significance for survival

**4**

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **3(a)** | A – nucleus (1)<br><br>B – chromosome (1)<br><br>Answers MUST be in this order | A - nuclear membrane<br><br>B – chromatid | **(2)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **3(b)(i)** | B - Homozygous | | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **3(b)(ii)** | phenotype | | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **3(c)(i)** | C - 3 | | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **3(c)(ii)** | An explanation linking the following points<br><br>• Jane is homozygous recessive / bb (1)<br><br>• children inherit one allele from each parent (1) | children can only inherit recessive allele /gene from mother<br>ORA regarding Jason<br><br>Accept gene<br><br>Ignore unqualified Punnett squares | **(2)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **3(c)(iii)** | An explanation that links the correct child with the following:<br>• Jacob (1)<br>• same sex (1)<br>• the same genotype / alleles / bb / both homozygous (1) | Ignore "same eye colour"<br>Accept gene<br>If candidate has mentioned another child they can still obtain mp2 and mp3. These are stand alone marks | **(3)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **2(a)(i)** | ☒ **D** bb | | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **2(a)(ii)** | Heterozygous | | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **2(a)(iii)** | A correctly completed Punnett square:<br><br>\| | B | b \|<br>\| b | Bb | bb \|<br>\| b | Bb | bb \| | | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **2(a)(iv)** | 50% | | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **2(b)(i)** | An explanation linking the following points:<br><br>• parents were carriers (1)<br><br>• Sue inherited a recessive allele from each parent / Sue has 2 recessive alleles (1) | heterozygous / both parents have a recessive allele<br><br>accept gene | **(2)** |