

Biomedical Admissions Test (BMAT)

Section 2: Biology

Questions by Topic

B6 - Gene Technologies

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B6: Gene Technologies - Questions by Topic

(Mark Scheme and explanations at the end)

- 1 The following questions are about DNA.
- 1 During genetic engineering you take a gene from an organism and insert it into another organism.
 - 2 Restriction enzymes are used to cut out the gene of interest.
 - 3 Restriction enzymes cut the DNA so there is a short section of single stranded DNA on one side of the gene.
 - 4 The bacterial plasmid DNA is cut open using the same restriction enzyme.
 - 5 The cut ends of the plasmid are not sticky.

Which of these statements are correct?

- A** 1, 2, 3 and 4
- B** 2, 3, 4 and 5
- C** 2, 3 and 4
- D** 1, 2 and 4
- E** 3, 2 and 5
- F** 2 and 3
- G** 3 and 4
- H** 2 and 5



- 2** Gene technologies enable us to create organisms with characteristics that are not normally present, producing genetically modified organisms. The following statements are about gene technologies.
- 1** A vector is inserted into the plasmid so it can carry the gene into the bacterial cell.
 - 2** The enzyme ligase is used to join the ends of the plasmid and the ends of the gene of interest.
 - 3** A plasmid with the cut ends is called a recombinant plasmid.
 - 4** A genetically modified organism can be cultured to produce a protein.
 - 5** Hydrogen bonds form between the ends of the plasmid and the ends of the gene of interest.

Which of these statements are correct?

- A** 1, 2, 3 and 4
- B** 1, 2, 3 and 5
- C** 1, 2 and 3
- D** 1, 2 and 5
- E** 2, 4 and 5
- F** 1 and 2
- G** 2 and 4
- H** 2 and 5



3 The following statements are about gene technologies.

- 1** The bacteria commonly used to create genetically modified plants have a Ti plasmid.
- 2** The useful gene is inserted into the plant cell chromosome by the Ti plasmid.
- 3** Enzyme DNA ligase is used to cut the gene of interest in plant cells.
- 4** The same technique is used to create genetically modified plant cells and genetically modified bacteria.
- 5** Pest resistance can be a characteristic of a genetically modified crop.

Which of these statements are correct?

- A** 1, 2, 3 and 4
- B** 2, 3, 4 and 5
- C** 2, 3 and 4
- D** 1, 2 and 5
- E** 1, 3 and 5
- F** 2 and 3
- G** 2 and 4
- H** 4 and 5

4 The following statements are about gene technologies.

- 1** Herbicide resistance is a characteristic of genetically modified crops.
- 2** Genetically modified crops can be used to produce nutrients to help prevent malnutrition.
- 3** Large quantities of medicine can be produced using genetically modified organisms.
- 4** There are greater side effects with using proteins made by bacteria.
- 5** Genetically modified crops can be used to produce human insulin.

Which of these statements are correct?

- A** 1, 2, 3 and 4
- B** 2, 3, 4 and 5
- C** 1, 2 and 3
- D** 2, 4 and 5
- E** 3, 4 and 5
- F** 1 and 3
- G** 2 and 3
- H** 4 and 5



5 The following statements are about gene technologies.

- 1** Gamete gene therapy is legal in the UK.
- 2** It is possible to control the position that the therapeutic gene is inserted into the chromosome.
- 3** Body cells can be modified in order to treat sickle cell anaemia.
- 4** Genetically modified organisms can be used to develop vaccines.
- 5** Human antibodies can be produced through genetically modified bacteria.

Which of these statements are correct?

- A** 1, 2, 3 and 4
- B** 1, 2, 4 and 5
- C** 1, 2 and 4
- D** 1, 3 and 4
- E** 2, 3 and 5
- F** 1 and 2
- G** 2 and 4
- H** 4 and 5

6 The following statements are about DNA.

- 1** Gene therapy treatment has few risks.
- 2** Totipotent stem cells are present before the development of the embryo.
- 3** Adult stem cells are found in the liver only.
- 4** Adult stem cells are pluripotent.
- 5** Stem cells can renew themselves by mitosis.

Which of these statements are correct?

- A** 1, 2, 3 and 4
- B** 2, 3, 4 and 5
- C** 1, 2 and 4
- D** 2, 3 and 4
- E** 2, 3 and 5
- F** 1 and 2
- G** 1 and 5
- H** 2 and 5



7 The following statements are about stem cells.

- 1 Stem cells are present throughout the life of a human.
- 2 Pluripotent stem cells can differentiate into any type of specialised cell.
- 3 Bone marrow stem cells can be used to treat diseases.
- 4 A risk of stem cell treatment is rejection by the immune system.
- 5 All types of stem cells differentiate into other cells.

Which of these statements are correct?

- A** 1, 2, 3 and 4
- B** 1, 3, 4 and 5
- C** 1, 2 and 4
- D** 2, 3 and 4
- E** 2, 3 and 5
- F** 1 and 2
- G** 1 and 5
- H** 2 and 5

8 The following statements are about stem cells and their use in medicine.

- 1 Risk of cancer can be increased when stem cells are used as treatment.
- 2 Stem cells can be used to treat burns.
- 3 Diabetes can be treated using stem cells.
- 4 iPSC can be produced using embryonic stem cells.
- 5 There is more chance of rejection when iPSC are used.

Which of these statements are correct?

- A** 1, 2, 3 and 5
- B** 1, 2, 4 and 5
- C** 1, 2 and 3
- D** 2, 3 and 4
- E** 2, 3 and 5
- F** 1 and 2
- G** 2 and 3
- H** 2 and 5



9 The following statements are about selective breeding.

- 1** Domesticated animals can be used for food and work.
- 2** Desirable characteristics in animals may be genetic.
- 3** Over time desirable characteristics decrease in the population.
- 4** Selective breeding increases genetic variation.
- 5** The likelihood of genetic conditions increases in animals that are selectively bred.

Which of these statements are correct?

- A** 1, 2, 3 and 5
- B** 1, 2, 4 and 5
- C** 1, 2 and 4
- D** 1, 2 and 5
- E** 2, 3 and 5
- F** 3 and 4
- G** 1 and 5
- H** 2 and 5

10 The following statements are about gene technology and selective breeding.

- 1** During selective breeding animals with desirable characteristics are bred together.
- 2** The zygote contains totipotent stem cells.
- 3** Induced pluripotent stem cells are found in the liver.
- 4** The ability for a population to adapt to the changing environment increases due to inbreeding.
- 5** Embryonic stem cell use is controversial.

Which of these statements are correct?

- A** 1, 2, 3 and 5
- B** 1, 2, 4 and 5
- C** 1, 2 and 5
- D** 2, 3 and 4
- E** 2, 3 and 5
- F** 1 and 2
- G** 2 and 5
- H** 3 and 4

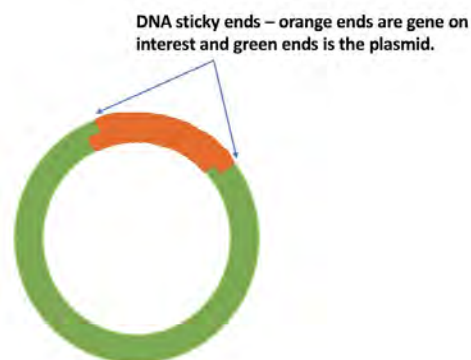


Answers and Explanations

1 The answer is D

- 1 is correct - as genetic engineering is used to take a copy of a gene which is of interest (gene for a particular characteristic) from one organism and then inserting that gene into the DNA of another organism. This will create a **genetically modified organism (GMO)/transgenic organism**.
- 2 is correct - a **restriction enzyme** is used in order to **cut the gene of interest** from the DNA of one organism.
- 3 is incorrect - it is true that restriction enzymes cut DNA however they cut it in a **staggered manner**, and leave short single-stranded DNA sections at **each end** of the gene. This means there are **two short sections** of single stranded DNA.

Diagram showing sticky ends:



- 4 is correct - the **same restriction enzyme** is used to cut the gene of interest out of the DNA of one organism and cut open the bacterial DNA plasmid. This ensures that the ends of the plasmid will have a **complementary short sequence of bases** to the sequence of bases on both ends of the gene of interest. This ensures that the gene of interest will be secured into the plasmid.
- 5 is incorrect - the ends of the **plasmid** that are cut open are sticky and so are the ends of the **gene of interest** that have been cut out of the DNA of an organism. Both these ends are **single stranded** and **sticky**.

Since **1**, **2** and **4** are the only correct statements, **D** must be the correct answer.



2 The answer is E.

- 1 is incorrect - it is true that a vector will guide the plasmid and the gene of interest into the bacterial cell. However a vector is not inserted into the plasmid, the **plasmid itself acts as a vector** to carry the gene into the bacterial cell.
- 2 is correct - it is true that the enzyme **DNA ligase** is used to join the **nucleotides of the plasmid DNA** and **nucleotides of the gene of interest** together.
- 3 is incorrect - because a **recombinant plasmid** is a plasmid in which the **gene of interest has been inserted**. The recombinant plasmid is a changed plasmid that has **DNA from more than one source**.
- 4 is correct - a genetically modified organism can be extremely useful to make a particular **protein**. A bacterial cell with a plasmid containing the gene of interest is called a **genetically modified organism (GMO)**. This GMO can be cultured by **cloning it** and the gene of interest inserted can be used to make the wanted protein.
- 5 is correct - it is true that **hydrogen bonds** form between the **complementary bases of the sticky ends** of the cut plasmid and the sticky ends of the cut gene of interest when they are mixed.

Since **2, 4** and **5** are the only correct statements, **E** must be the correct answer.

3 The answer is D

- 1 is correct - the **bacteria** that is commonly used to create **genetically modified plants** is **Agrobacterium tumefaciens**. These types of bacteria have a specific plasmid called a **Ti plasmid**.
- 2 is correct - when the bacteria that contains the gene of interest and the Ti plasmid (known as the recombinant Ti plasmid) it **infects the plant**. The Ti plasmid then enters the plant cell and a **portion of the Ti plasmid (containing the gene of interest)** is inserted into the **plant chromosome**.
- 3 is incorrect - the enzyme that is used to cut the gene of interest is a **restriction enzyme**. This is the same technique used to create genetically modified organisms.
- 4 is incorrect - the technique that is used to create genetically modified plants is **different** to the technique that is used to create genetically modified bacteria. This is





because **plant cells do not have plasmids**. The technique used to create the recombinant plasmid is the same to create genetically modified plants and bacteria, however the plasmid used for plants is called a **Ti plasmid**.

- 5** is correct - genetically modified plants have a lot of uses, one of the characteristics of **genetically modified crops** is **pest resistance**. An example of this is Bt cotton which is resistant to cotton bollworm, a pest that destroys cotton crops.

Since **1**, **2**, and **5** are the only correct statements, **D** must be the correct answer.

4 The answer is C

- 1** is correct - it is true that one of the characteristics of **genetically modified crops** is that it can be used to produce **herbicide resistance**. Genetically modified crops are made to be **resistant to weed killers** e.g. glyphosate-resistant soybean.
- 2** is correct - it is true that one of the characteristics of **genetically modified plants** is that they can be used to **produce nutrients that can help prevent malnutrition**. An example of this is golden rice that has been genetically modified so that there is an increased level of β -carotene, which can be used to aid in preventing vitamin A deficiency.
- 3** is correct - as the **genetically modified organisms** that are created which can be **cloned** and used to produce **large quantities of the protein/medicine** that is required.
- 4** is incorrect - this is because **proteins required for medicine** are made by **bacteria** but the **protein itself is human** (as the gene of interest used is human), therefore people that will take the medicine **should not have many side effects**.
- 5** is incorrect - in order to make **human insulin protein genetically modified bacteria** are used, not genetically modified plants.

Since **1**, **2** and **3** are the only correct statements, **C** must be the correct answer.



5 **B**

- 1 is incorrect - as gamete therapy is currently **illegal in the UK**. There are concerns that gamete therapy could cause **unexpected results**, which may cause problems that affect many organs in the body. The unexpected results may cause unexpected outcomes in the long term as the **therapeutic gene** would be **passed on to every new generation**.
- 2 is incorrect - this is because the therapeutic gene that needs to be inserted into the human cell is done so using a **special type of virus** which will enter the cell, however it is **not possible to control the position that the gene is inserted into the chromosome**.
- 3 is incorrect - it is true that you can use genetic modification in order to treat sickle cell anemia, however this is done through **genetically modifying stem cells**. Sickle cell anemia is a disease that will **affect the production of haemoglobin**. The **red blood cells** that carry haemoglobin molecules have a **slightly altered shape** and so they are not able to transport oxygen around the body very efficiently. Gene therapy involves **genetically modifying bone marrow cells (adult stem cells)** which can be used to create red blood cells that will carry haemoglobin proteins which have a shape that can **transport oxygen better**.
- 4 is correct - it is true that **genetically modified organisms** have been used to **develop vaccines** e.g. genetically modified baker's yeast is used to produce a recombinant hepatitis B vaccine.
- 5 is correct - it is true that **human antibodies** can be produced through **genetically modified bacteria**, e.g. a fermentation unit with E.coli bacteria have been genetically modified to produce human antibodies.

Since **4** and **5** are the only correct statements, **H** must be the correct answer.



6 The answer is H

- 1 is incorrect - gene therapy has a **lot of benefits** however there are also **risks** that come along with it. An example of a risk is if the therapeutic gene has **not been inserted into the chromosome accurately it can cause cancer**. If the therapeutic gene has been inserted into the chromosome **too close to a cancer-causing gene** then this gene can be **turned on** and thus cancer can arise.
- 2 is correct - it is true that in early life - when the **two gametes have fused together** at fertilisation and produce a **zygote** (which will then **divide by mitosis** to produce more cells), the cells that are produced are **totipotent stem cells**. These stem cells can **differentiate into any specialised cells** found in the human body.
- 3 is incorrect - **adult stem cells** are found in many places in the body, not just the liver. Adult stem cells are also found in the **heart, brain and skin as well as the liver**.
- 4 is incorrect - adult stem cells are **multipotent**, not pluripotent. Adult stem cells are undifferentiated however they can **only differentiate into a small number of cell types**.
- 5 is correct - it is true that any stem cell can **renew itself by mitosis**. This produces another stem cell that is also **undifferentiated**.

Since **2** and **5** are the only correct statements, **H** must be the correct answer.

7 The answer is B

- 1 is correct - it is true that stem cells are **present throughout our lives**. What changes is that the **number of stem cells** and **type of stem cells present** changes over the life of a human. At the start when a **zygote** is present after fertilisation the stem cells that are present are **totipotent**. As the cells divide by mitosis and the number of cells increases even more, an **embryo** is formed. An embryo has **embryonic stem cells** which are **pluripotent**. As an **adult stem cells** are also present which are **multipotent stem cells**.
- 2 is incorrect - **pluripotent stem cells** are **embryonic stem cells**, these can differentiate into any specialised cells in an adult however they cannot differentiate into **placenta cells**.



- 3 is correct - it is true that **bone marrow stem cells** that are present in adults can be used to **treat diseases**, such as **certain cancers**.
- 4 is correct - it is true that stem cell treatment also has risks associated with it. One of the risks is **rejection by the immune system** of the individual who is being treated. The transplanted stem cells can be identified as **foreign** hence the body rejects it.
- 5 is correct - it is true that all stem cells **differentiate into other cells**, however the number of different cell types the stem cells can differentiate into **reduces** from zygote to adult.

Since **1, 3, 4** and **5** are the only correct statements, **D** must be the correct answer.

8 The answer is C

- 1 is correct - it is true that when stem cells are used as therapy there is an **increased risk of the individual developing cancer**. This is because stem cells can **self renew by mitosis**, and excess dividing could result in cancer.
- 2 is correct - it is true that stem cells can be used to **treat burns**. The stem cells can be used to **replace damaged skin tissue**, so they can differentiate in order to **create skin tissue**.
- 3 is correct - it is true that stem cells can be used in order to **treat diabetes**. This is done by using the stem cells to **replace the faulty insulin secreting cells in the pancreas**.
- 4 is incorrect - iPSC are **induced pluripotent stem cells**, these are produced in the **laboratory** however they are produced using **adult body cells** not embryonic stem cells.
- 5 is incorrect - as induced pluripotent stem cells are produced using the patient's own body cells, there is **less chance that the cells will be rejected** by the body as a foreign object.

Since **1, 2** and **3** are the only correct statements, **C** must be the correct answer.





9 The answer is D

- 1 is correct - it is true that domesticated animals are used for **work and food**. These animals have been **tamed** and are heavily **dependent on humans** in order to survive. Domesticated animals can also be kept as **pets**.
- 2 is correct - it is true that certain characteristics that are desirable are genetic, hence are **controlled by genes**. Thus, these characteristics can be inherited from generation to generation and so can be **passed onto offspring** so they will also have the desirable characteristics.
- 3 is incorrect - this is because the desirable characteristics are selected for and offspring with these desirable characteristics are bred together. This is done over **many generations** and so the **desirable characteristics will increase in the population** over time.
- 4 is incorrect - selective breeding involves picking for certain **desirable characteristics** hence overtime there will be a **reduction in genetic variation** as the population will be **genetically similar**. This can occur due to **inbreeding**, which is breeding closely related animals together for several generations.
- 5 is correct - it is true that the **likelihood of genetic conditions increases** in animals that are selectively bred, this is due to **inbreeding** - animals that are closely related are bred together. Genetic conditions are often caused by **recessive alleles**. If within a population **genetic variation is low**, there is a greater chance that more individuals will have these recessive alleles - they are **homozygous recessive**, thus more chance that their offspring will have a **genetic disease**. E.g. it is common for dalmatians to have inherited hearing loss.

Since **1, 2** and **5** are the only correct statements, **D** must be the correct answer.



10 **The answer is C**

- 1 is correct - it is true that during selective breeding, animals that have **desirable characteristics** are bred together. If the desirable characteristics are **genetic** these can be **inherited** and can show up in the offspring.
- 2 is correct - a zygote forms **after fertilisation**. At this early stage in life the cells that are present are **totipotent stem cells**. These are stem cells that have the **ability to differentiate into any type of specialised cells** found in an adult human.
- 3 is incorrect - this is because induced pluripotent stem cells are made in the **laboratory** by scientists using **adult body cells**, hence they are not found naturally in the human body.
- 4 is incorrect - inbreeding results in a **reduction in genetic variation** in the animal population and thus this can **reduce the ability of the population to adapt** to a changing environment.
- 5 is correct - embryonic stem cells are present in the embryo and are **pluripotent**. These cells can differentiate into any specialised human cells **apart from placenta cells**. These cells can be used to treat conditions where **body cells are destroyed or damaged**, e.g. to replace neurons after the spinal cord has been injured. However these embryonic stem cells are obtained from a human embryo hence on **moral and ethical grounds** many people are against their use.

Since **1, 2** and **5** are the only correct statements, **C** must be the correct answer.

