PEARSON EDEXCEL IGCSE BIOLOGY · 4BI1

BIOLOGY



EXAM QUESTION PACK

SECTION 3: REPRODUCTION AND INHERITANCE (PACK 1)

SCORE	PERCENTAGE
/249	%

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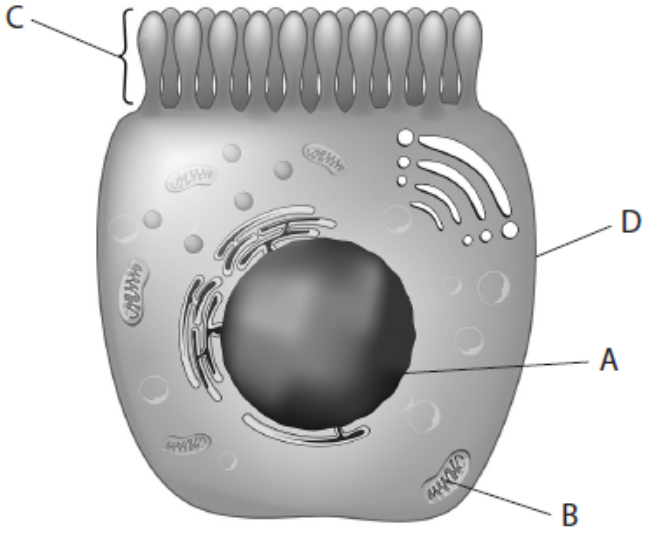
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Q1.

The diagram shows a cell found in the lining of the human small intestine.



(Source: © Designua / Shutterstock)

(a) (i) Which of the labelled structures is a microvillus?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(ii) Which of the labelled structures produces ATP?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) These cells form the lining of the small intestine.

Explain how the structure of the small intestine is adapted for absorption.

(4)

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(c) Cells in the human placenta also have microvilli.

Describe the role of the human placenta.

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(Total for question = 9 marks)

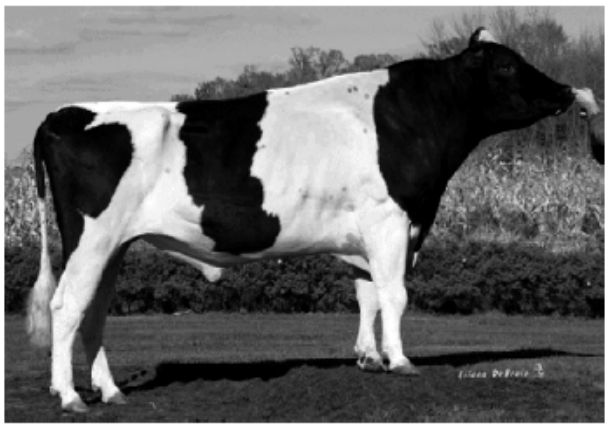
Q2.

Read the passage below.

Use the information in the passage and your own knowledge to answer the questions that follow.

Toystory

Toystory is a bull who was born in 2001. The photograph shows Toystory.



In the world of dairy farming Toystory is a famous bull. He fathered 500 000 offspring but did not mate with any cows. He was able to father so many offspring because his semen was collected and then used to fertilise cows using artificial insemination.

Toystory's mother was a high milk producer and his father was a popular bull. He was sold for $4 000 by his owner to a specialist breeding company called Genex.

Genex started to collect semen from Toystory when he was four years old. The semen is carefully collected, using a teaser animal and an artificial rubber vagina.

The semen is divided into many separate samples. These samples are put in small straws and frozen in liquid nitrogen. The straws can then be sold and sent to dairy farmers around the world to inseminate their cows. A total of 2.4 million samples of semen from Toystory was sold in more than 50 countries around the world.

Toystory's reputation grew as the offspring he fathered went on to be high milk producers. His semen straws sold for over $60 each. Bull semen can now be sold as sexed or unsexed samples, with sexed samples being more expensive to purchase.

Toystory was highly valued because his offspring produced large quantities of milk of a desired composition. His semen was effective at getting cows pregnant, his daughters gave birth easily and were strong. He had a rare mix of fertility, genetics and appearance.

One of his daughters sold for $300 000 in 2009. His record number of offspring is unlikely to be beaten. This is because bulls are often retired earlier as new genetic advances are discovered.

(a) Suggest why Genex waited until Toystory was four years old before beginning to collect his semen (line 9).

(1)

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(b) Explain how the semen from the bull is used to fertilise cows using artificial insemination.

(2)

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(c) (i) Suggest why the semen is stored in liquid nitrogen (line 13).

(1)

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(ii) Sexed semen is guaranteed to produce offspring of one sex.

Suggest why dairy farmers would prefer to used sexed semen (line 19).

(1)

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(d) Determine the percentage success of Toystory's semen samples in producing offspring (line 2 and line 15).

(2)

percentage success = ... %

(e) Describe how scientists could investigate which of two bulls is the best to use as a father in dairy farming.

(3)

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(f) Explain why the composition of milk is important to consumers (line 22).

(2)

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(g) (i) Scientists are now using cloning to produce animals.

Describe the stages that are required to clone a bull.

(4)

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(ii) Give two advantages of using cloning rather than selective breeding to produce offspring.

(2)

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2 .....

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(Total for question = 18 marks)

Q3.

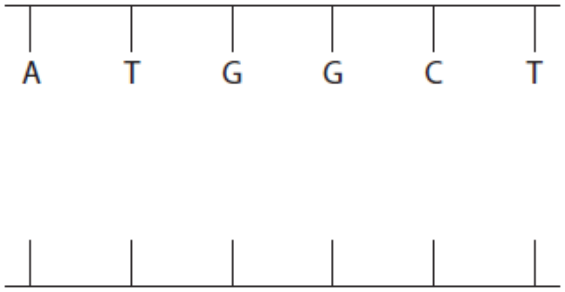
Decomposer bacteria are involved in the nitrogen cycle.

The bacteria release an enzyme called urease.

(a) The diagram shows part of one strand of DNA used to make urease.

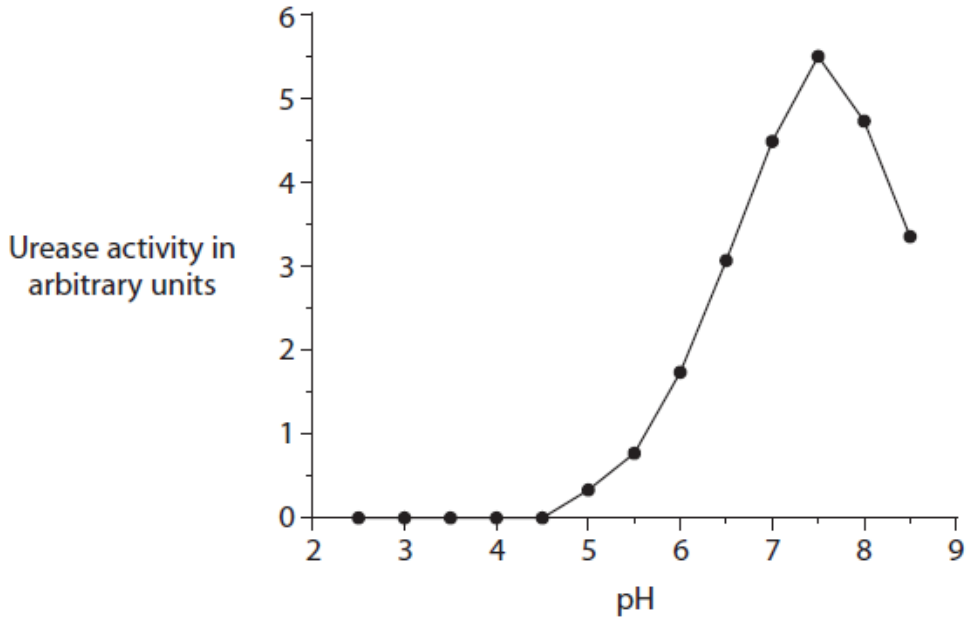
Complete the diagram by giving the missing bases on the other strand of DNA.

(1)



(b) Urease acts on urine to produce ammonia.

The graph shows how pH affects the activity of urease.



(i) Which of these is the optimum pH for urease?

(1)

☒ **A** 2.5

☒ **B** 4.5

☒ **C** 7.5

☒ **D** 8.5

(ii) Explain the activity of urease at pH 8.5

(2)

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(c) Describe the role of the other bacteria involved in the nitrogen cycle.

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(Total for question = 9 marks)

Q4.

Beta thalassaemia is a genetic condition caused by a mutation in a gene for haemoglobin.

People with beta thalassaemia produce less haemoglobin and fewer red blood cells than people without the condition.

(a) Explain why people with beta thalassaemia may experience severe tiredness.

(2)

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(b) A new treatment for beta thalassaemia has been developed that edits the haemoglobin gene. These are the steps in the treatment.

• remove blood stem cells from a patient's bone marrow

• put a strand of RNA and an enzyme into the blood stem cells to correct the haemoglobin gene

• use drugs to destroy the patient's remaining bone marrow cells

• replace the patient's bone marrow cells with the modified stem cells

The modified stem cells that are in the bone marrow now produce red blood cells containing sufficient haemoglobin.

(i) The strand of RNA used in this treatment is complementary to one strand of the DNA in the haemoglobin gene.

Give the base sequence of RNA that is complementary to this sequence of DNA.

(2)

DNA strand A A T G G C G G C T C A

RNA strand

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(ii) Protein synthesis of the modified gene will produce haemoglobin.

Describe the stages of this protein synthesis.

(4)

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(iii) The standard treatment for beta thalassaemia is a weekly blood transfusion.

The new treatment has so far been tested on two patients, with these results.

• both patients started making large numbers of red blood cells with sufficient haemoglobin

• both patients experienced serious side effects from the drugs used, needing to spend several months in isolation in hospital before recovering

• 15 months after the treatment, neither patient required further blood transfusions

• both patients were able to exercise normally without feeling tired

Evaluate the use of the new treatment compared to weekly blood transfusions.

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(Total for question = 12 marks)

Q5.

Read the passage below. Use the information in the passage and your own knowledge to answer the questions that follow.

Making Enough Blood for the World

A blood transfusion is the transfer of blood from a donor into a patient. Blood transfusions are routine medical procedures that save the lives of millions of people every year.



(Source: beerkoff/Shutterstock)

The first successful blood transfusions were performed in the early twentieth century after scientists discovered that there are four main blood groups, A, B, AB and O. The blood groups are due to the presence of proteins, called antigens, on the surface of red blood cells. There are two main protein antigens called A and B. If a patient is given blood with antigens different to their own cells, their immune system will make antibodies against that antigen. The antigens present on the surface of red blood cells for each blood group are shown in the table.

Blood group	Antigens present
A	A
B	B
AB	A and B
O	neither A nor B

Currently, blood transfusions are carried out with blood that has been donated by healthy people. The World Health Organisation calculates that there are 118.5 million blood donations collected globally every year. Of these donations, 40% are collected from a small group of high-income countries. This means that there is a shortage of blood in many countries so the hunt is on to find an alternative.

Scientists have found a way to make artificial red blood cells. They made spheres of cell membranes filled with haemoglobin. These artificial cells are then suspended in sodium chloride solution. These artificial red blood cells have no proteins on their surface. Another way of making red blood cells is being developed in the United Kingdom. A research team has used stem cells to produce red blood cells with blood group O. The red blood cells produced are then suspended in sodium chloride solution.

Both methods produce large quantities of safe red blood cells. There may be other advantages as well, artificial blood would always have the same concentration of solutes and will not clot when stored. Critics have pointed out that the artificial blood will only transport oxygen and that blood has many more functions.

(a) Name the type of cell that produces antibodies. (Lines 8 and 9)

(1)

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(b) Human blood groups are controlled by three alleles, I^A, I^B and I^O.
The I^A and I^B alleles are codominant and the I^O allele is recessive.

(i) State what is meant by the term **codominant**.

(1)

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(ii) Two parents have genotypes of I^AI^O and I^BI^O.

Which of these are all the possible blood groups of their children?

(1)

☒ **A** A and B

☒ **B** A, B and O

☒ **C** AB and O

☒ **D** A, B, AB and O

(c) Calculate the number of blood donations collected per year from the high-income countries. (Lines 14 and 15)

Give your answer in standard form.

(2)

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(d) Some scientists have suggested that spherical artificial red blood cells transport oxygen less

efficiently than normal human red blood cells.

Explain why the shape of the artificial red blood cells reduces the efficiency of oxygen transport compared to normal human red blood cells. (Lines 18 and 19)

(3)

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(e) Suggest why artificial blood does not clot when stored. (Lines 26 and 27)

(1)

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(f) Explain why the artificial red blood cells are suspended in sodium chloride solution instead of in water. (Line 20)

(2)

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(g) (i) Explain why stem cells can be used to make large quantities of red blood cells. (Lines 22 and 23)

(2)

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(ii) Suggest why the scientists made red blood cells with blood group O. (Lines 22 and 23)

(2)

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(h) Give two substances found in blood plasma that are not present in the artificial blood. (Lines 28 and 29)

(2)

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2 .....

(Total for question = 17 marks)

Q6.

The brain is part of the central nervous system.

(a) Name the other part of the central nervous system.

(1)

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(b) Huntington's disease (HD) is caused by a mutation in the gene for making a protein called huntingtin.

This protein damages nerve cells in the brain.

HD is caused by a dominant allele.

A heterozygous parent and a homozygous recessive parent have a child.

(i) What is the probability of this child having HD?

(1)

☒ **A** 0.0

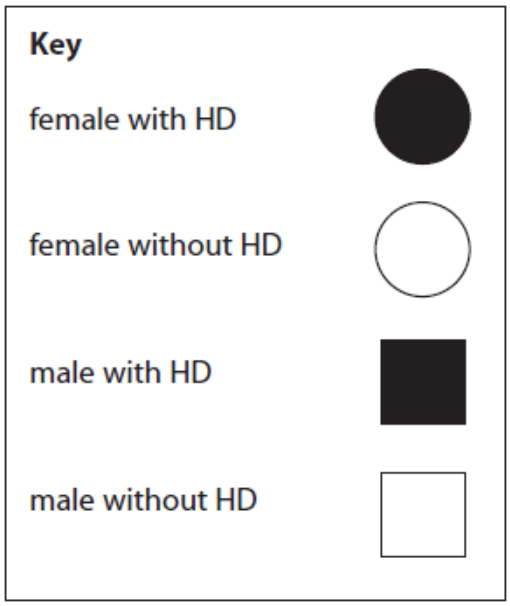
☒ **B** 0.25

☒ **C** 0.5

☒ **D** 1.0

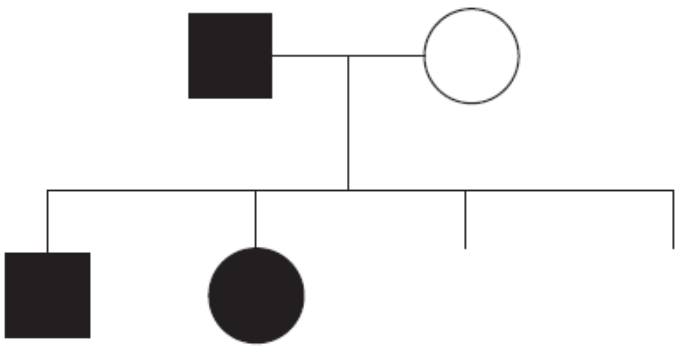
(ii) These parents have three more children.

The key shows the possible sex and phenotype of the individuals with or without HD.



The family pedigree gives the predicted sex ratio and the predicted phenotype ratio for two of the children. Complete the family pedigree by giving the predicted sex ratio and predicted phenotype ratio for the other two children.

(2)



(c) A drug can reduce the damage to nerve cells in the brains of people with HD.

The drug binds to messenger RNA produced by the mutated gene for huntingtin protein.

Suggest ways that this drug reduces damage to nerve cells in people with HD.

(3)

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(Total for question = 7 marks)

Q7.

Scientists can now produce farm animals by cloning. Since Dolly the sheep was born in 1996 many different species have been cloned.

The form of cloning used is called somatic cell cloning.

The first ever clone of a champion racehorse was announced in 2005 in Italy.

The foal was cloned from Pieraz, a world champion in long-distance horse races.

(a) Describe the stages scientists could use to clone a male horse.

(4)

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(b) Pieraz was castrated (had his testicles removed) at a young age.

Explain why this stopped him reproducing normally but did not stop him being used to produce a foal by cloning.

(3)

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(c) Suggest why horseracing does not allow the use of non-natural methods of breeding, including cloning.

(1)

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(d) State one difference between cloning an organism and genetically modifying an organism.

(1)

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(Total for question = 9 marks)

Q8.

DNA and RNA are involved in the processes of transcription and translation.

(a) State three ways in which the structure of a DNA molecule differs from the structure of an RNA molecule.

(3)

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(b) Describe the differences between the processes of transcription and translation.

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(c) The DNA molecule codes for the amino acids used to make proteins.

There are four different bases in DNA and 20 amino acids used to make proteins.

Use this information to show that a minimum of three bases on the DNA molecule is needed to code for each amino acid.

(3)

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(Total for question = 11 marks)

Q9.

(a) A DNA strand has this sequence of bases.

C A T T C A A T T C A T T T C

(i) How many amino acids does this sequence of bases code for?

(1)

☒ **A** 1

☒ **B** 3

☒ **C** 5

☒ **D** 15

(ii) Write down the complementary mRNA code for this sequence of bases.

(2)

(iii) A student reads that DNA codons are non-overlapping.

Suggest what is meant by the term non-overlapping.

You should refer to the sequence of bases in your answer.

(2)

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(b) Describe what happens in the translation stage of protein synthesis.

(4)

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(c) State what is meant by the genome of an organism.

(1)

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(Total for question = 10 marks)

Q10.

(a) The diagram shows one strand of DNA from a section of a gene.

ATTCCGAGT

What would be the complementary sequence of bases on the messenger RNA produced from this strand of DNA?

(1)

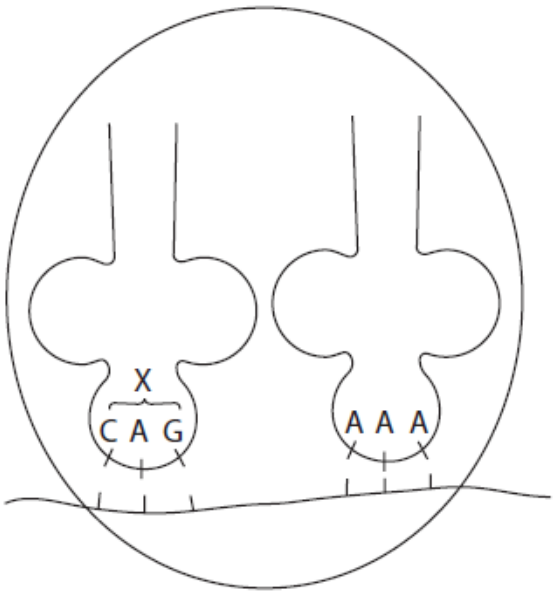
☒ **A** TAAGGCTCA

☒ **B** ATTCCGAGT

☒ **C** UAAGGCUCA

☒ **D** AUUCCGAGU

(b) The diagram shows a stage during protein synthesis.



Which row gives the correct names for the stage of protein synthesis shown and the sequence of bases labelled X?

(1)

	Stage of protein synthesis	X
☒ A	transcription	anticodon
☒ B	transcription	codon
☒ C	translation	anticodon
☒ D	translation	codon

(c) Explain how a mutation in a gene can affect the phenotype of an organism.

(3)

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(d) In an accident at a nuclear power station, radioactive material was released into the surrounding areas of land.

Scientists investigated the impact of this on a species of butterfly.



(Source: septembersun.123rf.com/PAL)

Samples of adult butterflies were collected from an area near the power station two months after the release of the radioactive material.

The percentages of butterflies with abnormalities were calculated.

The butterflies were then mated in the laboratory and the percentage of offspring with abnormalities calculated.

The experiment was repeated with butterflies collected from the same area, 10 months after the release of the radioactive material.

(i) Describe how the scientists could have sampled the population of butterflies in the area.

(3)

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(ii) The results of the investigation are shown in the table.

Butterfly generation	Percentage of butterflies with abnormalities	
	two months after the accident	ten months after the accident
adult	12.4	28.1
offspring	18.3	60.2

The scientists concluded that the increased level of radioactivity has led to an increased rate of mutation of DNA.

Discuss the scientists' conclusion referring to data from the table to support your answer.

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(Total for question = 13 marks)

Q11.

The DNA molecule codes for the production of proteins in cells.

(a) Describe the structure of a DNA molecule.

(3)

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(b) (i) DNA is used as a template for protein synthesis.

Which of the following is the correct sequence for this synthesis?

(1)

☒ **A** DNA → transcription → mRNA → translation → amino acid chain

☒ **B** amino acid chain → mRNA → transcription→ DNA → translation

☒ **C** DNA → translation → mRNA → transcription → amino acid chain

☒ **D** mRNA → translation → transcription → amino acid chain → DNA

(ii) A codon is made of three bases. There are four different bases.

How many different codons can be produced?

(1)

number of different codons = ...

(c) (i) Describe how a mutation in the DNA of a cell can affect the functioning of an enzyme.

(3)

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(ii) Explain why some mutations have little effect on the phenotype of an organism.

(2)

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(iii) State **one** factor that will increase the incidence of mutations.

(1)

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(Total for question = 11 marks)

Q12.

Some mice have yellow hair and some mice have brown hair.

The gene for hair colour in mice has two alleles. The dominant allele is H and the recessive allele is h.

A scientist crosses a yellow-haired male mouse with a yellow-haired female mouse.

He predicts a 3 : 1 ratio of yellow to brown mice in the offspring.

(a) Give the genotype of the yellow parent mice that would produce this 3 : 1 ratio.

(1)

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(b) The scientist then crosses three other pairs of male and female yellow mice.

The table shows his results.

	Number of offspring	
	yellow	brown
Cross one	7	3
Cross two	8	4
Cross three	6	3

Calculate the ratio of the total number of yellow to brown mice for these crosses.

(1)

ratio = ...

(c) Suggest reasons why the predicted ratio of 3 : 1 is not obtained.

(4)

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(Total for question = 6 marks)

Q13.

Variation in a population can have different causes.

(a) Which of these will **not** lead to an increase in genetic variation in a population of plants?

(1)

☒ **A** asexual reproduction

☒ **B** insect pollination

☒ **C** mutation

☒ **D** wind pollination

(b) Explain how a change in the DNA of a microorganism can reduce its ability to digest a substance.

(5)

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(c) Explain why a change in DNA may not affect the phenotype of an organism.

(4)

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(Total for question = 10 marks)

Q14.

Bags made from starch are better for the environment than plastic bags made from fossil fuels.

Bags made from starch are decomposed by microorganisms such as soil fungi.

(a) (i) Which of these is a feature of fungi?

(1)

☒ **A** chloroplasts in the cytoplasm

☒ **B** starch stored in the cytoplasm

☒ **C** thread-like hyphae

☒ **D** walls made of cellulose

(ii) The soil fungi release an enzyme called amylase that digests the bag.

What is the product of this digestion?

(1)

☒ **A** amino acids

☒ **B** fatty acids

☒ **C** glycerol

☒ **D** maltose

(iii) Amylase is a protein.

Describe how protein is made in a cell.

(5)

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(b) A student investigates the effect of soil pH on the decomposition of bags made from starch.

She uses this method.

- cut two small squares from a bag
- measure the mass of each small square
- place one square in a beaker of soil with a pH of 7.0
- place the other square in a beaker of soil with a pH of 9.0
- after 10 days, remove the squares and measure their mass again

The table shows the student's results.

pH of soil	Mass of square in g		Percentage loss in mass (%)
	at start	after 10 days	
7.0	2.00	1.00	50.0
9.0	2.10	0.62	

(i) Calculate the percentage loss in mass shown by the square in pH 9.0 soil.

(1)

percentage = ...

(ii) Calculate the difference between the percentage loss in mass for the two squares.

(1)

difference = ...

(iii) Explain how the student could improve her method so that she can obtain more accurate results.

(4)

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(Total for question = 13 marks)

Q15.

Read the passage below. Use the information in the passage and your own knowledge to answer the questions that follow.

Male contraception

Hormonal contraception has been used by women for many years to control their fertility. A recent study investigated a new contraceptive injection to be used by men.

The study was done in seven different countries: the United Kingdom, Australia, Germany, Italy, India, Indonesia and Chile. The researchers investigated a total of 320 healthy men aged between 18 and 45, all with female partners aged between 18 and 38.

All the men had normal sperm counts and produced sperm with no abnormalities in shape or movement. They had no sexually transmitted infections and no medical or mental health illnesses. Their female partners were healthy and did not intend to become pregnant within the next two years. They were willing to accept a low, but unknown, chance of becoming pregnant.

The study had two phases. These were the initial suppression phase lasting 26 weeks, followed by a contraceptive effectiveness testing phase lasting just over one year. In the suppression phase, the men were given injections of a drug called progestin and the hormone testosterone. This was repeated at 8, 16 and 24 weeks. Progestin inhibits sperm production and reduces the release of testosterone. Semen samples were collected every two weeks to monitor the sperm count. During this phase, couples had to use alternative barrier methods of contraception, such as condoms.

When a man had produced two consecutive semen samples with a sperm count of less than one million per cm^3, they began the contraceptive effectiveness testing phase. During this phase, the men continued to receive regular injections every eight weeks for just over one year. Semen samples were taken at the same time as each injection to monitor the sperm count. If the sperm count went above one million per cm^3, the injections were stopped. At this point the men left the trial and other methods of contraception were resumed.

The contraceptive injections prevented pregnancies in the partners of 98.4% of the men. However, a number of men reported side effects. For example, just under half of the men developed acne (skin infections and irritation) and one in five reported mood disorders. In approximately 5% of the men, their sperm count had not returned to normal one year after stopping the injections. Despite the side effects, more than three-quarters of the men, and their partners, said they would be happy to continue to use this new method of contraception.

The scientists concluded that this was a valuable early-stage trial that gave a good indication of the potential safety and effectiveness of the progestin and testosterone injections for male contraception.

(a) Suggest why the men in the study had to be able to produce sperm with no abnormalities in shape or movement
(lines 8 and 9).

(2)

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(b) (i) The contraceptive injection contained the drug progestin (lines 15 and 16).

Progestin is similar in structure and function to progesterone.

Describe the roles of progesterone in the human female body.

(2)

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(ii) Suggest why the injections also contain the hormone testosterone (lines 15 and 16).

(1)

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(iii) State where in the male body testosterone is produced.

(1)

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(c) (i) Give the purpose of the initial suppression phase of the study (line 13).

(1)

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(ii) State why the sperm count is monitored during the suppression phase (lines 18 and 19).

(1)

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(iii) State why alternative contraception was used during the suppression phase (lines 19 and 20).

(1)

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(d) Suggest why sperm count continues to be monitored during the testing phase (lines 25 and 26).

(1)

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(e) Calculate the number of men whose partners became pregnant during the study (lines 6 and 28).

(2)

number of men = ...

(f) Evaluate the use of progestin and testosterone injections as a method of contraception.

(4)

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(Total for question = 16 marks)

Q16.

Read the passage below. Use the information in the passage and your own knowledge to answer the questions that follow.

Moving plants

Flowering plants reproduce using different methods to transfer the pollen from plant to plant. This cross-pollination enables plants to produce offspring that show genetic variation. The transfer can be done by animals such as insects or by wind.

The reliance on animals and wind for reproduction does not end with pollination. Flowering plants also need a mechanism to disperse their fruits or the seeds they contain. This seed dispersal means that seeds producing new young plants will germinate away from the parent plant.



wings on a sycamore

(Source: © joanna wnuk/Shutterstock)



fluff on a dandelion

(Source: © Viktorija Reuta/Shutterstock)



spines on burdock

(Source: © Paulpixs/Shutterstock)

The simplest method of seed dispersal uses gravity. The seeds are within heavy fruit, which fall from the tree when they are ripe. Although some of the fruit may roll away from the parent plant, most remain close to the parent plant.

Animal dispersal is when plants rely on animals to transport their seeds to a different area. This may be because the seeds are surrounded by a brightly-coloured and sweet-tasting fruit. Examples of this are soft fruits such as raspberry and hard fruits such as apple.

Animals may also carry seeds in a different way. Many plants produce fruits or individual seeds covered in hooks or spines that attach the seeds to the animals' fur. The seeds are then carried away from the parent plant. Eventually, the seeds may fall off, or be rubbed off by the animal. Examples of plants using this form of dispersal are burdock and sea holly.

Some plants provide seed pods with a mechanism that ejects the seeds from the pod by force. All of these rely on the effect of evaporation of water in the seed pod, so this method of seed dispersal usually takes place in sunlight. Examples of plants using this form of dispersal are gorse bushes and lupins.

Wind is one of the main methods of seed dispersal. Some tall trees produce seed pods that have wings, which allow the seeds to travel long distances. Some seed pods have two wings such as the sycamore while others have one wing such as the ash.

There are also lightweight adaptations that help seeds to be blown by the wind. These include various sorts of fluff that increase the surface area of the seed, so that it can be picked up by the slightest breeze. Examples of plants using this form of dispersal are thistle and dandelion.

The last method uses water. Trees found on tropical beaches often have their seeds carried away by the sea. The seeds have woody, waterproof coverings enabling them to float in the water for long periods. Coconuts are a well-known example.

(a) Explain how cross-pollination can lead to an increase in genetic variation. (Lines 2–3)

(2)

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(b) (i) Explain the advantages of the seeds germinating away from the parent plant. (Line 8)

(3)

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(ii) Give one advantage of a seed germinating close to the parent plant. (Line 11)

(1)

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(c) Explain the conditions needed for seed germination.

(3)

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(d) Explain why some seeds are surrounded by a brightly-coloured and sweet-tasting fruit. (Lines 13–14)

(2)

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(e) Large numbers of tomato plants are often found growing along the sides of drains and settling beds on sewage farms.

Suggest a reason for this observation.

(1)

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(f) Give the reason why sunlight is required for lupin seeds to be dispersed. (Lines 21–24)

(1)

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(g) Describe an experiment you could carry out to investigate how the presence of fluff on dandelion seeds affects how fast they fall. (Lines 30–31)

(3)

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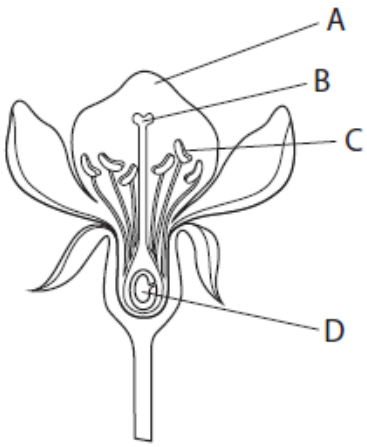
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(Total for question = 16 marks)

Q17.

Flowers are involved in plant reproduction.

The diagram shows a section through a flower with parts labelled A, B, C and D.



(a) (i) Which part of the flower makes pollen grains?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(ii) What part of the flower is the stigma?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) After a pollen grain lands on the stigma of a flower, a pollen tube grows.

Explain the role of the pollen tube.

(3)

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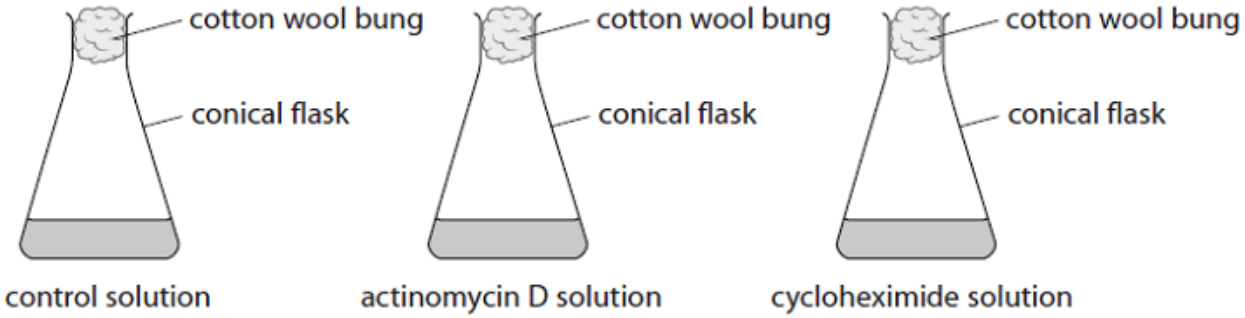
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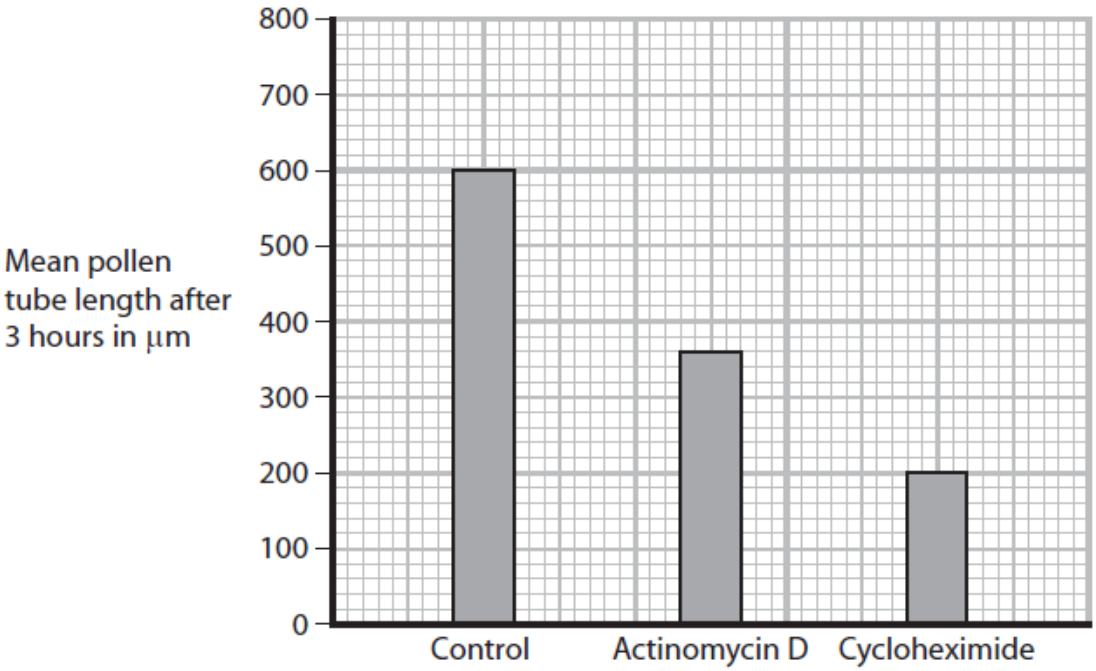
A scientist investigates the effect of three different solutions on the growth of pollen tubes using this apparatus.



This is the scientist's method.

- place a different solution in three different flasks
- add pollen grains to the solution in each flask
- leave the grains in each solution for three hours
- take a sample of pollen grains from each solution
- measure the length of the pollen tubes in each sample

The graph shows the scientist's results.



(i) Calculate the difference between the mean rate of pollen tube growth in the control solution and the mean rate of pollen tube growth in the actinomycin D solution.

Give your answer in µm per hour.

(2)

difference = ... µm per hour

(ii) Actinomycin D prevents transcription and cycloheximide prevents translation.

Use this information and your own knowledge to explain the results of this investigation.

(4)

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(d) Describe a method the scientist could use to observe pollen grains.

(3)

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(Total for question = 14 marks)

Q18.

Read the passage below. Use the information in the passage and your own knowledge to answer the questions that follow.

Haemolytic disease

Haemolysis is the term used to describe the bursting of red blood cells. Haemolytic disease occurs when the red blood cells burst in the body of a foetus in a pregnant woman. The bursting of the red blood cells affects the development of the foetus into a baby.

The red blood cells burst when certain antibodies from the mother pass across the placenta. The antibodies attach to protein molecules called antigens. These antigens are on the surface of the foetal red blood cells. The protein antigen is called the rhesus factor and is made using the genetic code found on the dominant allele, D, during the production of red blood cells in bone marrow.

Homozygous dominant and heterozygous individuals have cells with the antigen. These individuals have the rhesus positive blood group. Homozygous recessive individuals have cells that do not have the antigen. These individuals have the rhesus negative blood group.

During the birth of a rhesus positive baby, some red blood cells may leak into the circulatory system of the mother. This happens as the placenta pulls away from the wall of the uterus. A rhesus negative mother will make antibodies that destroy rhesus positive red blood cells. This is not a problem for the child that has just been born. However, if the mother becomes pregnant again with another rhesus positive foetus, the antibodies will harm the foetus.

Haemolytic disease can be avoided by treating a rhesus negative woman at risk of having a second rhesus positive child. This treatment involves the mother having an injection during and after pregnancy. The injection destroys rhesus positive cells in the mother's blood before the cells can cause an immune response.

If the foetus is rhesus positive, the pregnancy is carefully monitored for signs of haemolytic disease. Monitoring includes regular ultrasound scans of the foetus and measuring the amount of antibody in the mother's blood. A change in the concentration of the antibody in the mother's blood, due to her secondary immune response, can lead to dangerous haemolysis. If a foetal blood test confirms a low number of red blood cells, a blood transfusion can be done *in utero* to replace the burst foetal red blood cells.

(a) Explain why bursting of red blood cells affects the development of a foetus (lines 3 and 4).

(2)

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(b) The dominant allele codes for the production of the protein that will act as an antigen.

Describe how the dominant allele leads to the production of RNA during protein synthesis (lines 7 to 9).

(3)

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(c) Give the reason why proteins cannot be made by red blood cells (lines 7 to 9).

(1)

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(d) Give one piece of evidence from the passage that shows that antibodies are smaller than red blood cells.

(1)

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(e) (i) A mother who is homozygous recessive for the rhesus factor has a child with a father who is heterozygous.

Give the genotypes of the mother, the father, their gametes and the possible genotypes of the child.

(3)

(ii) Give the probability that the child will be rhesus positive.

(1)

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(f) Explain why the concentration of the rhesus antibody in the mother's blood rises quickly to harmful levels if she has a second child who is Rhesus positive (lines 16 to 19).

(3)

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(g) Suggest what is meant by the term *in utero* (line 30).

(1)

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(h) A foetus with haemolytic disease can be given a blood transfusion.

Suggest the blood group of the source of the cells used for this transfusion (lines 29 and 30).

(1)

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(Total for question = 16 marks)

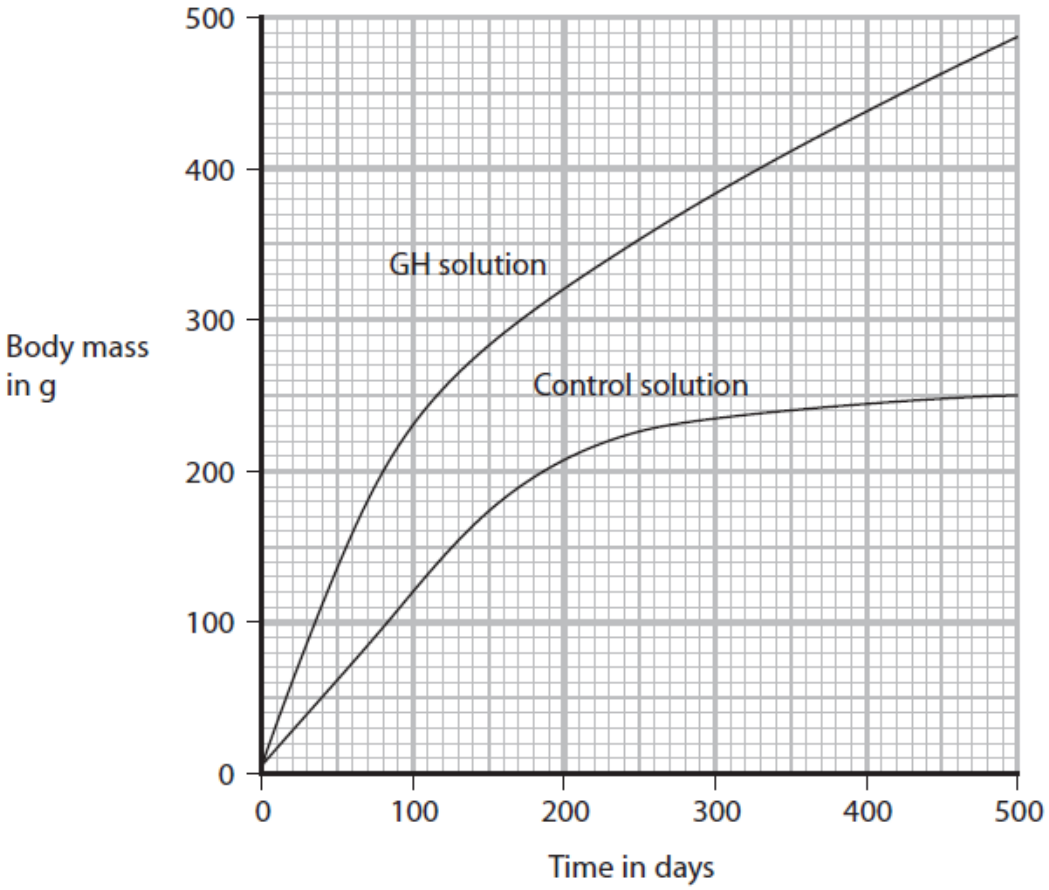
Q19.

A scientist investigates the effect of growth hormone (GH) on the body mass of rats.

This is his method.

- give one rat a GH solution every day for 500 days
- give another rat a control solution every day for 500 days
- measure the mass of each rat each week for 500 days

The graph shows his results.



(a) Suggest how the control solution differs from the GH solution.

(1)

.....

.....

(b) Calculate the average rate of growth of the rat given GH solution from 100 days to 500 days.

Give your answer in g per day.

(2)

rate of growth = ... g per day

(c) The scientist controlled all the variables in his investigation.

Suggest two abiotic variables he controls.

(2)

1 .....

2 .....

(d) The scientist repeats his investigation using more rats.

Explain why using more rats improves his investigation.

(2)

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(e) GH increases transcription in cells.

Explain why this affects the growth of rats.

(3)

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(Total for question = 10 marks)

Q20.

(a) The table gives information about some hormones involved in the menstrual cycle.

Complete the table by giving the missing information.

(6)

Hormone	Name of structure that secretes hormone	Functions of hormone
FSH	.....	1 ..... 2 stimulates oestrogen secretion
.....	pituitary	1 ..... 2 stimulates development of corpus luteum
.....	ovaries	1 repairs lining of uterus 2 stimulates LH secretion
progesterone	.....	1 maintains the lining of uterus 2 inhibits LH

(b) State what is meant by the term **menstruation**.

(1)

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(c) A girl starts to ovulate at the age of 12 years and continues to ovulate until she reaches the age of 51 years.

[Assume her menstrual cycle is 28 days and she releases one egg per cycle.]

Estimate the maximum number of eggs she could release in her lifetime.

Give your answer to two significant figures.

(3)

number of eggs = ...

(d) Give a reason why a female does not produce as many offspring as the number of eggs she releases.

(1)

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(Total for question = 11 marks)

Q21.

In humans, males are heterogametic because they have two different sex chromosomes. Females are homogametic because they have two similar sex chromosomes.

(a) Give the sex chromosomes in the body cell of a human male.

(1)

.....

(b) In birds, females are heterogametic and have a Z chromosome and a W chromosome.

(i) What are the sex chromosomes in the body cell of a male bird?

(1)

☒ **A** XY

☒ **B** ZW

☒ **C** ZY

☒ **D** ZZ

(ii) A male and female bird have four offspring.

Calculate the probability that these offspring will all be female.

(2)

probability = ...

(c) Human females generally reach puberty between the ages of 11 and 16.

At puberty, hormonal changes occur that cause females to start ovulating.

(i) The table lists the four hormones involved in controlling the menstrual cycle.

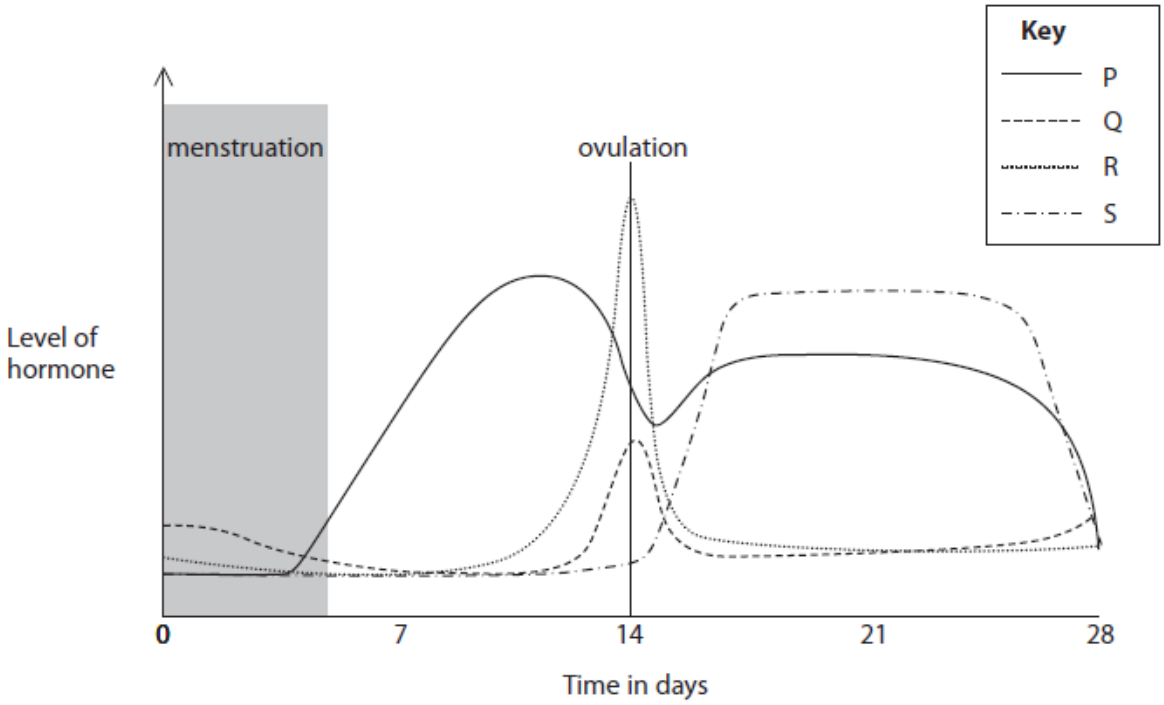
It also shows the source of secretion and a function of each hormone.

Complete the table by giving the missing information.

(4)

Hormone	Source	Function
FSH		stimulates follicle growth
LH	pituitary	
oestrogen		repairs the uterus lining
progesterone	ovary	

(ii) The chart shows the changes in the levels of the four hormones during the menstrual cycle.



Each letter, P, Q, R and S, represents a different hormone.

Give the correct letter for each hormone.

(3)

FSH .....

LH .....

Oestrogen .....

Progesterone .....

(Total for question = 11 marks)