National
Qualifications
2022

X840/76/12

Human Biology
Paper 1 — Multiple choice

THURSDAY, 19 MAY
9:00 AM – 9:40 AM

Total marks — 25

Attempt ALL questions.

You may use a calculator.

Instructions for the completion of Paper 1 are given on *page 02* of your answer booklet X840/76/02.

Record your answers on the answer grid on *page 03* of your answer booklet.

Space for rough work is provided at the end of this booklet.

Before leaving the examination room you must give your answer booklet to the Invigilator; if you do not, you may lose all the marks for this paper.

X8407612

Total marks — 25

Attempt ALL questions

1. The following list shows some procedures in which stem cells can be used:

1. Corneal repair
2. Drug testing
3. Skin regeneration.

Which procedures involve the therapeutic use of stem cells?

A 1 only

B 2 only

C 1 and 3 only

D 1, 2 and 3

2. The table shows the average cost of treating individuals with different types of cancer in the UK depending on their stage of diagnosis.

Type of cancer	Average cost of treatment (£)	
	Early stage diagnosis	Late stage diagnosis
Colon	3000	13 000
Ovarian	5000	15 000
Rectal	4000	12 000
Lung	8000	13 000

Which of the following statements is correct?

A Colon cancer is always the least expensive cancer to treat.

B Lung cancer is always the most expensive cancer to treat.

C Late stage diagnosis of ovarian cancer results in a 300% increase in the cost of treatment compared to early stage diagnosis.

D Early stage diagnosis of rectal cancer results in a 67% decrease in the cost of treatment compared to late stage diagnosis.

3. A section of a molecule of DNA has 12 000 bases with a 1:3 ratio of adenine to cytosine.

The number of guanine bases in this section is:

A 1500

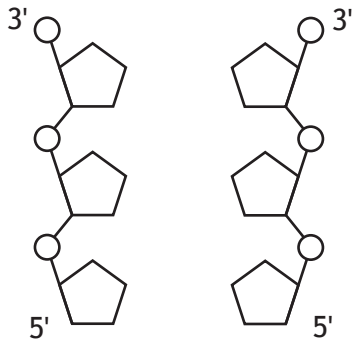
B 3000

C 4500

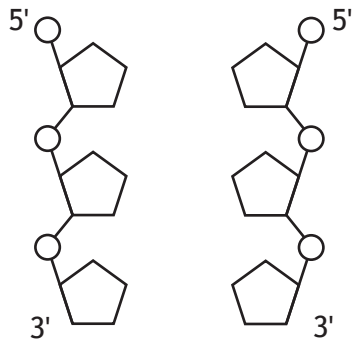
D 9000.

4. Which diagram shows the correct arrangement and labelling of the strands found in a section of a molecule of DNA?

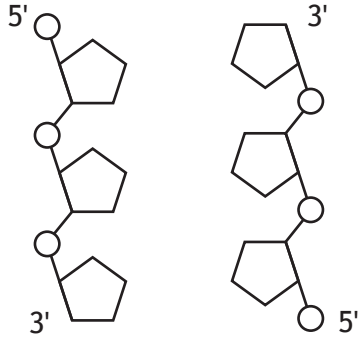
A



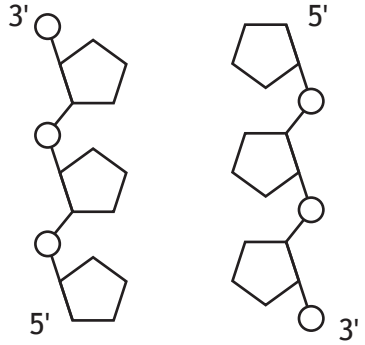
B



C

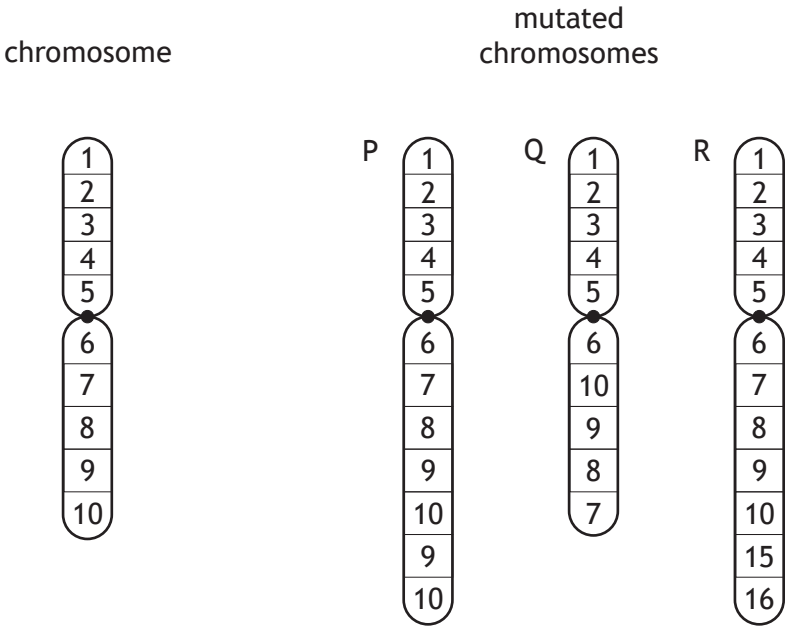


D



[Turn over

5. The diagram shows a chromosome and mutated versions of the same chromosome.
Each numbered segment on the chromosomes represents a gene.



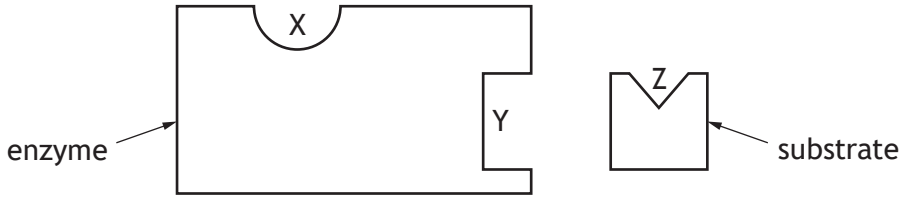
Which row in the table shows the type of mutations that have occurred?

	Chromosome P	**Chromosome Q**	**Chromosome R**
A	duplication	inversion	translocation
B	duplication	translocation	insertion
C	translocation	duplication	inversion
D	insertion	inversion	translocation

6. Which statement describes induced fit between an enzyme and its substrate?

A The active site changes shape after the substrate binds.
B The substrate changes shape after the enzyme binds.
C The active site changes shape before the substrate binds.
D The substrate changes shape before the enzyme binds.

7. The diagram shows an enzyme and its substrate.



Which row in the table identifies the sites where a competitive and a non-competitive inhibitor could bind?

	Competitive inhibitor	**Non-competitive inhibitor**
A	X	Y
B	X	Z
C	Y	Z
D	Y	X

8. Saliva contains the enzyme amylase, which breaks down starch into maltose.

The presence of starch can be tested for by adding iodine solution, which turns blue/black if starch is present.

In an investigation, four test tubes were set up in a water bath at 37 °C. Each test tube contained 10 cm^3 of starch solution and 2 cm^3 of amylase. 2 cm^3 of buffer solutions of different pH values were added to each test tube.

A sample of the contents of each test tube was removed every 30 seconds for 10 minutes and tested with iodine.

Identify the independent variable in this investigation.

A pH of solution in each test tube

B Volume of starch solution in each test tube

C Temperature of the test tubes in the water bath

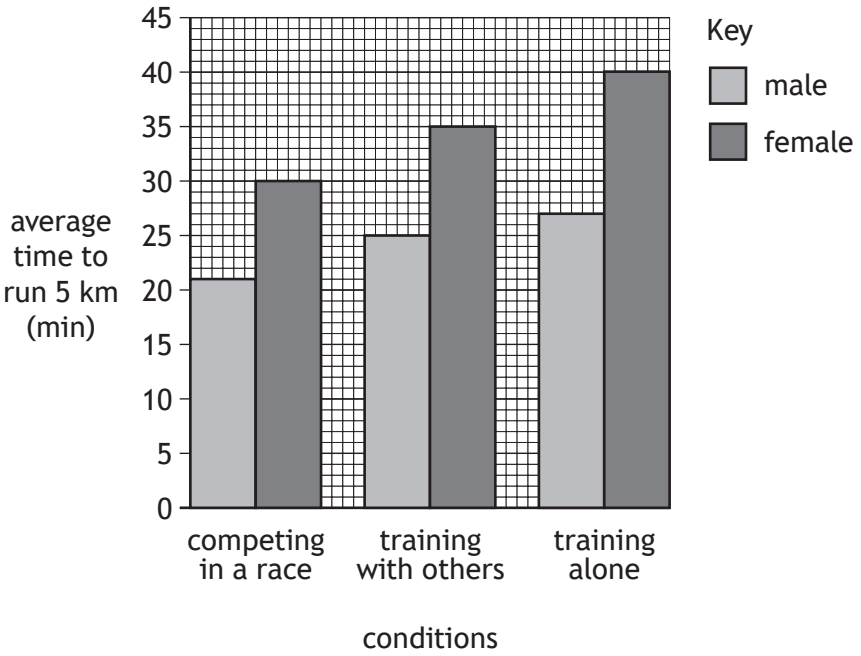
D Time taken for iodine solution to no longer turn blue/black

[Turn over

9. Which row in the table matches a substance with the stage of respiration in which it is involved?

	Substance	Stage
A	pyruvate	citric acid cycle
B	oxaloacetate	citric acid cycle
C	oxaloacetate	electron transport chain
D	pyruvate	electron transport chain

10. The graph shows the results of a survey carried out on members of a running club who ran 5 km under three different conditions.



What is the percentage improvement shown by females competing in a race compared to training alone?

A 10%

B 12.5%

C 25%

D 33.3%

11. The onset of puberty in males is triggered by a secretion from the:

A pituitary gland

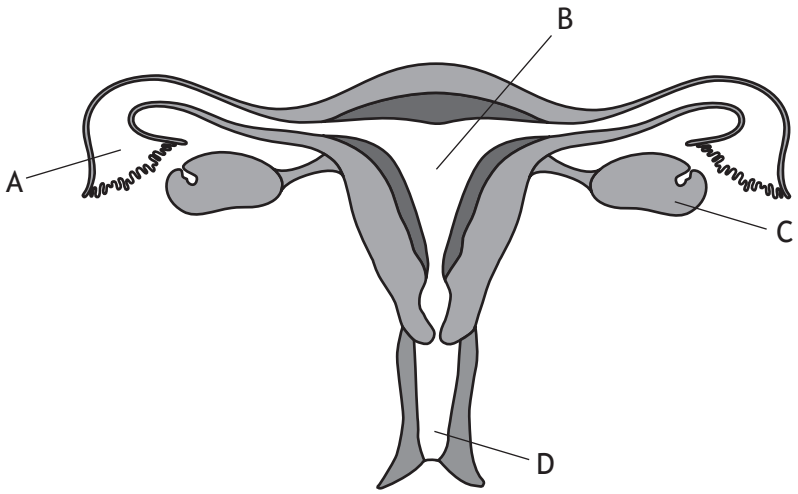
B hypothalamus

C interstitial cells

D seminal vesicles.

12. During IVF a fertilised egg is incubated until at least eight cells are formed.

Which letter indicates the location in the reproductive system into which this ball of cells would be transferred?



13. Red-green colour blindness is caused by an allele that is sex-linked and recessive.

A woman's father has the allele for colour blindness, but her mother does not.

The woman has a son with a man who is not colour blind.

What is the percentage chance that their son will be colour blind?

A 0%

B 25%

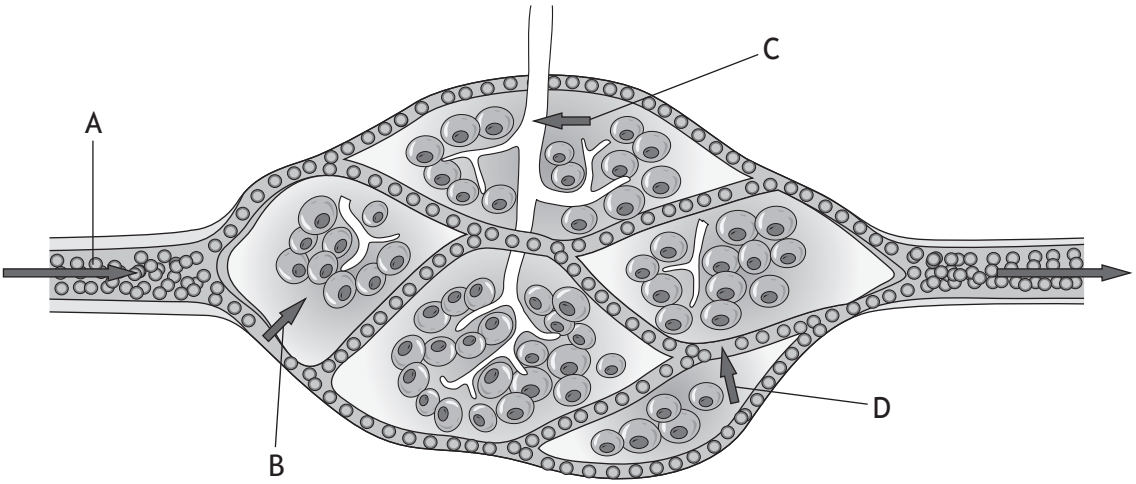
C 50%

D 75%

[Turn over

14. The diagram shows a capillary network within a tissue.

Which arrow represents pressure filtration of plasma?



15. Which row in the table shows the typical blood pressure in a blood vessel of a young adult during the cardiac cycle?

	Blood pressure (mmHg)	Blood vessel	Cardiac cycle stage
A	80	vein	diastole
B	80	artery	systole
C	120	vein	diastole
D	120	artery	systole

16. Which row in the table describes features typical of type 2 diabetes?

	Onset	Effect
A	Occurs in childhood	Cells unable to produce insulin
B	Occurs in childhood	Cells less sensitive to insulin
C	Develops later in life	Cells unable to produce insulin
D	Develops later in life	Cells less sensitive to insulin

17. The table shows the number of new cases of diabetes diagnosed in the UK in 2013 and 2018.

	Number of new cases of diabetes (thousands)	
Year / Location	**2013**	**2018**
England	2700	3200
Scotland	250	300
Wales	170	200
Northern Ireland	80	100

Which statement is correct for the number of new cases between 2013 and 2018?

A Scotland had a 50% increase in new cases.

B Wales had the lowest increase in new cases.

C England had a yearly average increase of 100 new cases.

D Northern Ireland had a 25% increase in new cases.

18. The increase in an athlete's heart rate and breathing rate during a race involves:

A sympathetic neurons of the autonomic nervous system

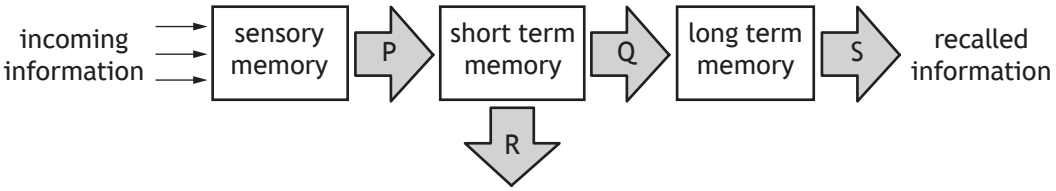
B parasympathetic neurons of the somatic nervous system

C sympathetic neurons of the somatic nervous system

D parasympathetic neurons of the autonomic nervous system.

[Turn over

19. The diagram shows the processing of information within memory.



Which row in the table identifies the memory processes shown in the diagram?

	Memory process		
	Retrieval	**Encoding**	**Displacement**
A	S	Q	R
B	P	R	Q
C	S	P	Q
D	Q	P	R

20. The following are methods used to aid memory:

1. Chunking
2. Elaboration
3. Organisation.

Which of these methods can be used to improve the transfer of information from short term to long term memory?

A 1 only

B 1 and 3 only

C 2 and 3 only

D 1, 2 and 3

21. The following steps occur during the inflammatory response:

1. Blood flow increases.
2. Histamine is released by mast cells.
3. Phagocytes accumulate at the site of infection.
4. Vasodilation occurs and capillary permeability increases.

In which sequence do these steps occur?

A 2, 1, 4, 3
B 4, 2, 1, 3
C 4, 1, 3, 2
D 2, 4, 1, 3

22. Autoimmune diseases are a result of:

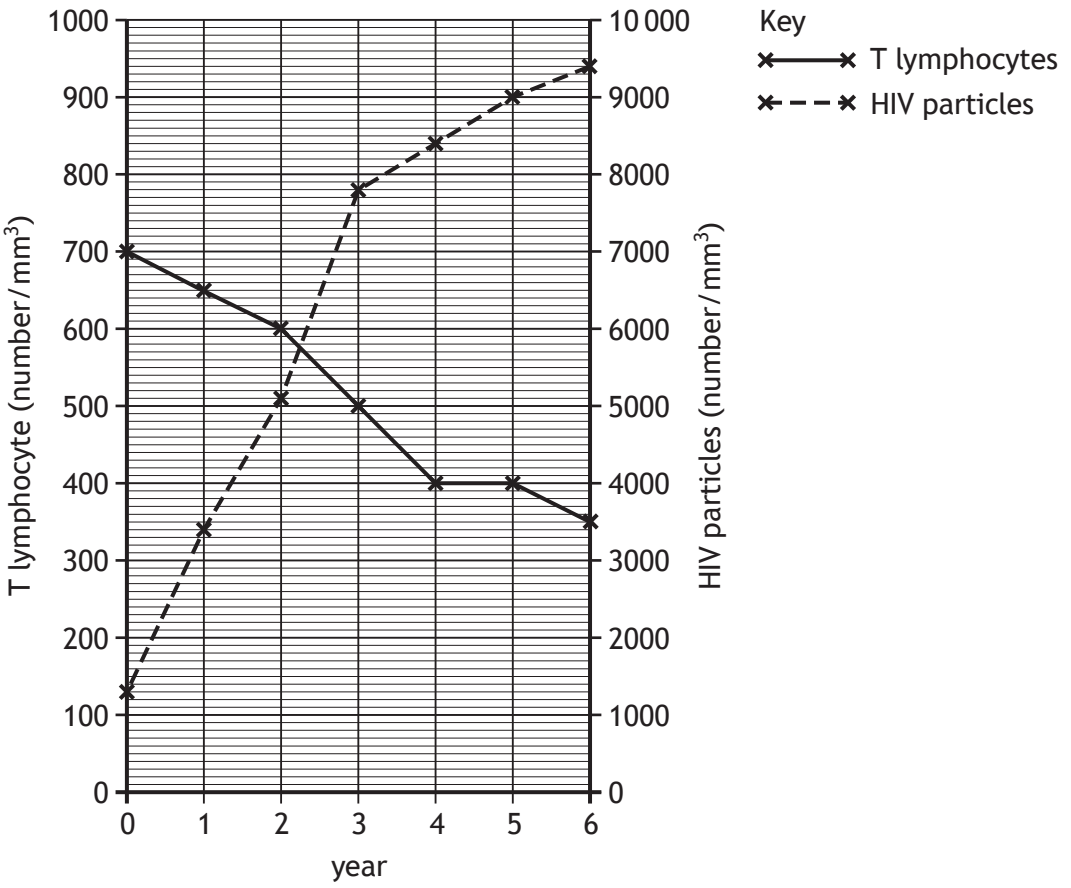
A T lymphocytes responding to pathogens
B T lymphocytes responding to self-antigens
C B lymphocytes responding to pathogens
D B lymphocytes responding to self-antigens.

23. Some individuals have allergies, which mean they cannot receive certain vaccines. These individuals may benefit from vaccination programmes through:

A herd immunity
B antigenic variation
C non-specific immunity
D personalised medicine.

[Turn over

24. The graph shows the relationship between the number of T lymphocytes and the number of HIV particles present in the blood of an infected individual over a 6-year period.



Which of the following statements is **not** correct?

A The ratio of T lymphocytes to HIV particles at year 4 is 1:21.

B The HIV particle number increased fastest between years 2 and 3.

C The T lymphocyte number decreases continuously over the 6-year period.

D The HIV particle number is always higher than the T lymphocyte number.

25. Which experimental design feature reduces the magnitude of experimental error in a clinical trial?

A A placebo control

B A suitable group size

C Double-blind protocols

D Using randomised groups

[END OF QUESTION PAPER]

FOR OFFICIAL USE

National Qualifications 2022

Mark

X840/76/01

Human Biology Paper 2

THURSDAY, 19 MAY

10:10 AM – 12:30 PM

X8407601

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Number of seat

Date of birth

Day | Month | Year

Scottish candidate number

Total marks — 95

Attempt ALL questions.

You may use a calculator.

Question 15 contains a choice.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers and rough work is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting. Any rough work must be written in this booklet. Score through your rough work when you have written your final copy.

Use **blue** or **black** ink.

Before leaving the examination room you must give this booklet to the Invigilator; if you do not, you may lose all the marks for this paper.

SQA ©

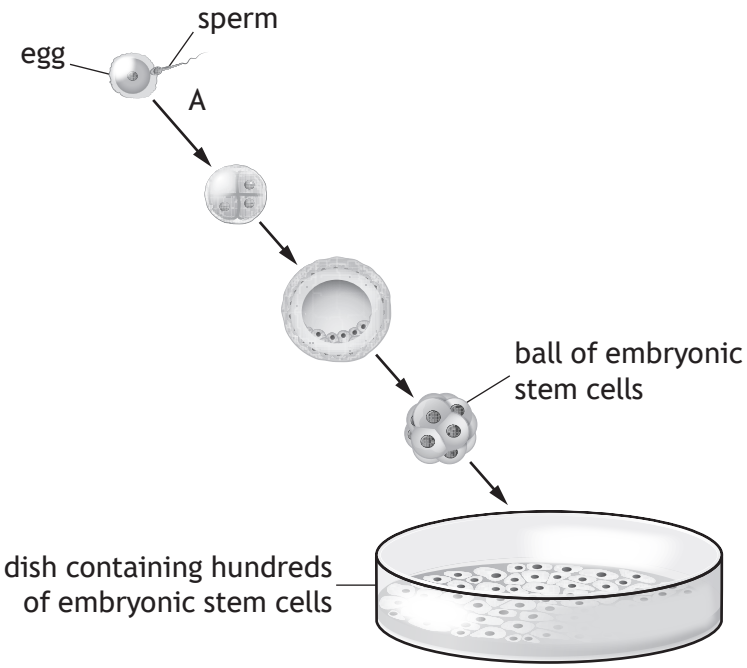
X8407601 01

Total marks — 95

Attempt ALL questions

Question 15 contains a choice

1. The diagram shows some of the stages involved in the formation of embryonic stem cells for use in a laboratory.



(a) (i) Name the type of cells that divide to form sperm and eggs. **1**

_____

(ii) Name the type of cell division occurring at A. **1**

_____

(iii) Explain why embryonic stem cells are described as being pluripotent. **1**

_____

_____

1. (continued)

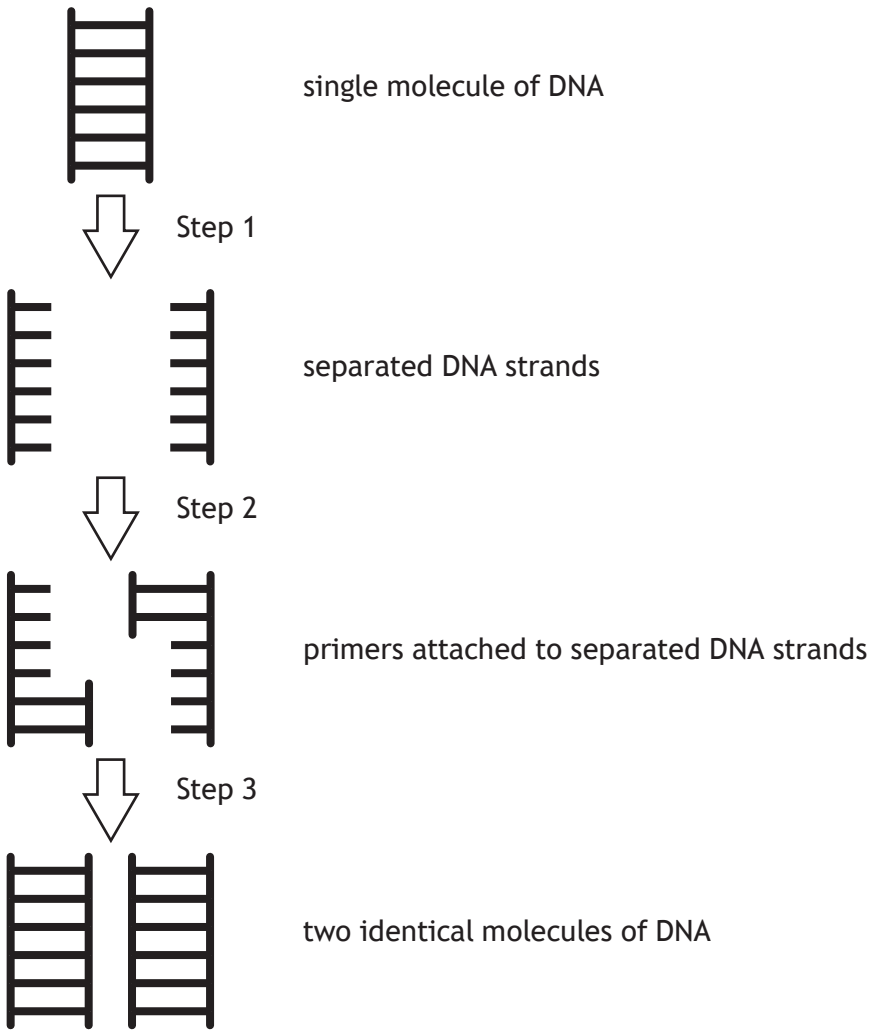
(b) Explain how differentiation of tissue stem cells leads to the production of specialised cells such as red blood cells. **1**

(c) Research has developed a type of stem cell that can be cultured in a laboratory directly from a patient's own somatic cells.

Suggest a benefit to the patient of using these stem cells in therapeutic treatments. **1**

[Turn over

2. The diagram represents three steps during one cycle of the Polymerase Chain Reaction (PCR).



(a) Give values to describe the change in the temperature that occurs in step 2. **1**

2. (continued)

(b) (i) Name the enzyme used in step 3. **1**

_____

(ii) Suggest an advantage of using a heat tolerant form of this enzyme during PCR. **1**

_____

_____

(c) Calculate the number of DNA molecules produced from a single molecule of DNA after 10 cycles of PCR. **1**

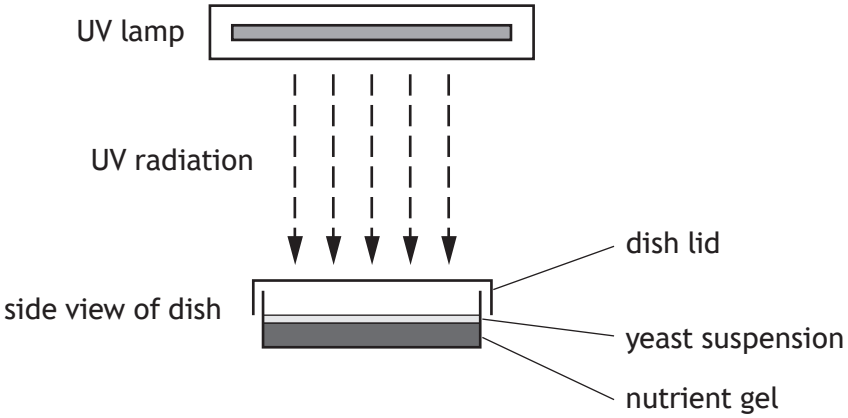
Space for calculation

_____DNA molecules

[Turn over

3. An investigation was carried out into the effect of UV radiation exposure time on the survival of yeast cell colonies.

20 cm^3 of a concentrated yeast cell suspension was diluted with 80 cm^3 of water. 6 dishes containing a nutrient gel had 2 cm^3 of the diluted yeast cell suspension added to them. Each dish was then exposed to UV radiation for different periods of time. UV radiation induces mutation in these yeast cells.



The dishes were then transferred to an incubator for 48 hours before the number of yeast cell colonies in each dish was counted.

(a) State two variables, other than those described above, that would need to be controlled when setting up this investigation. **2**

1. _____

_____

2. _____

_____

(b) Suggest why the concentrated yeast cell suspension was diluted with water before it was added to the dishes. **1**

_____

_____

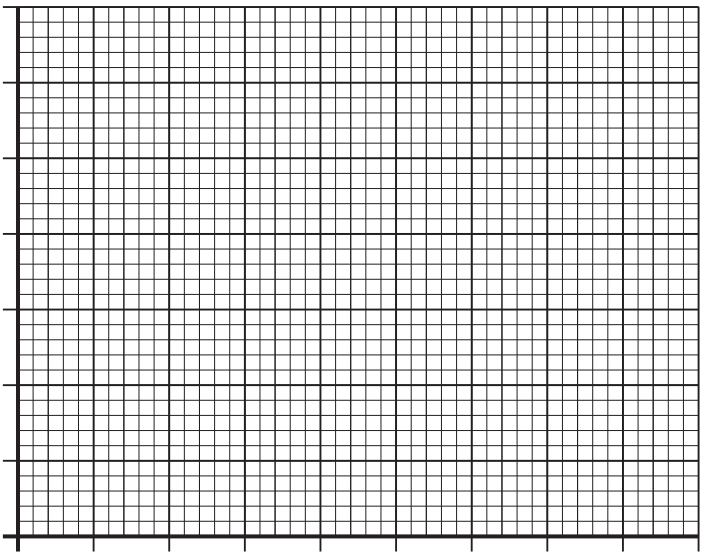
3. (continued)

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

Length of UV exposure time (min)	Number of yeast cell colonies
1	70
3	66
5	58
7	46
9	30

(i) Draw a line graph to show the data in the table. **2**

(Additional graph paper, if required, can be found on *page 31*.)



(ii) State the conclusion that can be drawn from these results. **1**

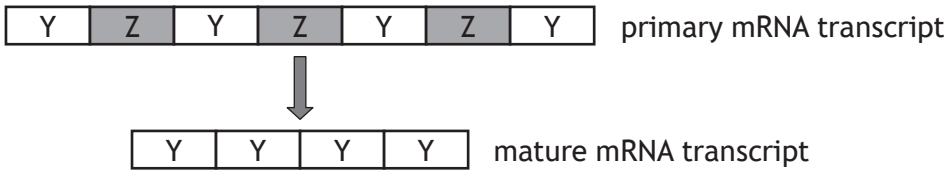
_____

_____

(iii) Predict the number of yeast cell colonies that would be present if the exposure time was 11 minutes. **1**

_____

4. The diagram shows a strand of mRNA undergoing splicing.



(a) Name the regions labelled Y. **1**

_____

(b) The primary transcript contained 3150 bases. The total number of bases removed by the splicing process was 600. The mature transcript includes one start and one stop codon, which do not code for amino acids in the final protein.

Calculate how many amino acids are present in the protein coded for by the mature transcript. **1**

Space for calculation

_____amino acids

(c) (i) Name the process that results in different proteins being expressed from a single gene. **1**

_____

(ii) Describe how this process leads to the formation of different proteins. **1**

_____

_____

_____

4. (continued)

(d) A splice-site mutation resulted in the following mature mRNA transcript.

Y	Z	Y	Y	Y

(i) Describe the effect that this mutation has had on the mature mRNA transcript. **1**

(ii) Suggest how this mutation may affect the structure of the protein formed. **1**

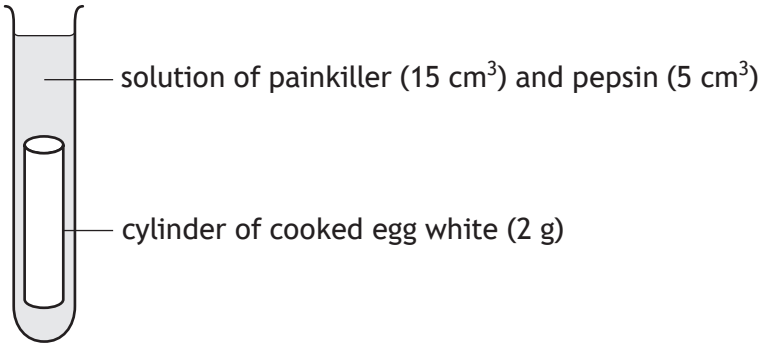
[Turn over

5. Some painkillers are recommended to be taken after a meal. However, painkillers can inhibit the action of digestive enzymes.

An investigation was carried out into the effect of different painkillers on the inhibition of the digestive enzyme, pepsin.

Cooked egg white is composed of protein, which can be broken down by pepsin.

Test tubes containing different painkiller solutions were set up as shown. A control test tube was also set up.



The test tubes were left for 24 hours at 37 °C and then the mass of egg white broken down was calculated.

The table shows the results of the investigation.

Painkiller	Mass of egg white broken down (g)
Paracetamol	1.4
Aspirin	1.1
Ibuprofen	1.3

(a) Two tablets of each painkiller were used to make up the solutions.

Suggest why this may not have allowed a valid comparison of the effects of the different painkillers. **1**

_____

_____

5. (continued)

(b) Describe the contents of the solution in the control tube. **1**

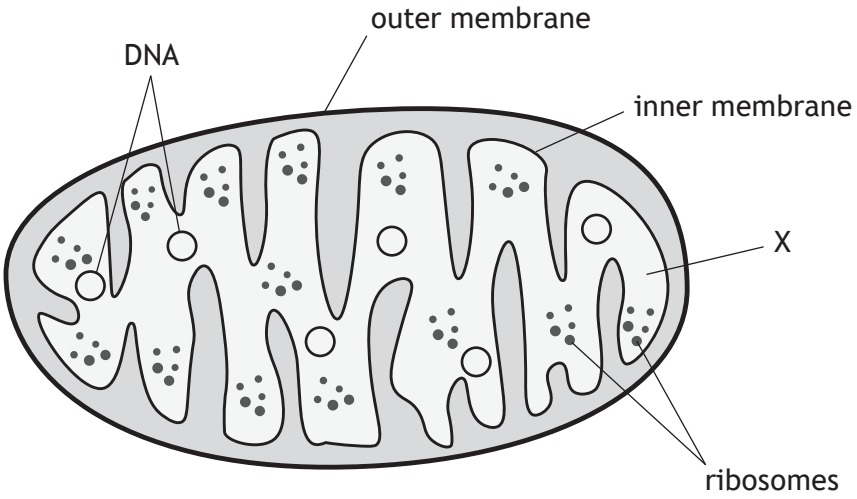
(c) Describe how the results were calculated in this investigation. **1**

(d) State which painkiller had the greatest inhibitory effect on pepsin activity. **1**

(e) Describe how the reliability of the results from this investigation could be improved. **1**

[Turn over

6. The diagram represents a mitochondrion from a cell.



(a) (i) Name the region of the mitochondrion labelled X. **1**

_____

(ii) Name the stage of respiration that occurs at the inner membrane. **1**

_____

(iii) Explain why this mitochondrion can synthesise proteins. **1**

_____

_____

_____

6. (continued)

(b) Mitochondrial disease is a condition caused by mutations in the genes needed for mitochondria to function effectively.

(i) Suggest why muscle is one of the main tissues affected by mitochondrial disease. **1**

(ii) Name the type of muscle fibre most likely to be affected by mitochondrial disease. **1**

(iii) Explain why some individuals with mitochondrial disease are unable to carry out endurance activities such as long distance running. **1**

(c) In another form of mitochondrial disease, affected individuals produce a non-functional form of an enzyme, which results in large quantities of lactate in their cells.

Suggest the function of this enzyme in **unaffected** individuals. **1**

[Turn over

7. A number of hormonal changes occur in a woman's body during the menstrual cycle.

(a) (i) State one function of each of the following hormones in the menstrual cycle. **2**

FSH _____

_____

Oestrogen _____

_____

(ii) Name the structure within an ovary that produces progesterone. **1**

_____

(b) A woman took a daily oral contraceptive pill.

(i) Explain how taking this pill would affect the FSH concentrations in her blood during her menstrual cycle. **2**

_____

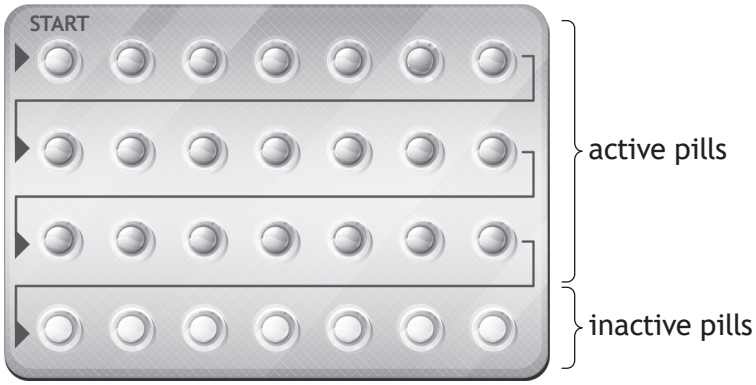
_____

_____

_____

7. (b) (continued)

(ii) One type of oral contraceptive is made up of 21 active pills and 7 inactive pills.



The inactive pills are normally identical to the active pills but contain no active ingredients.

Explain why menstruation usually occurs during the days that the woman takes the inactive pills. **1**

(c) The 'morning after pill' is an emergency hormonal contraceptive pill.

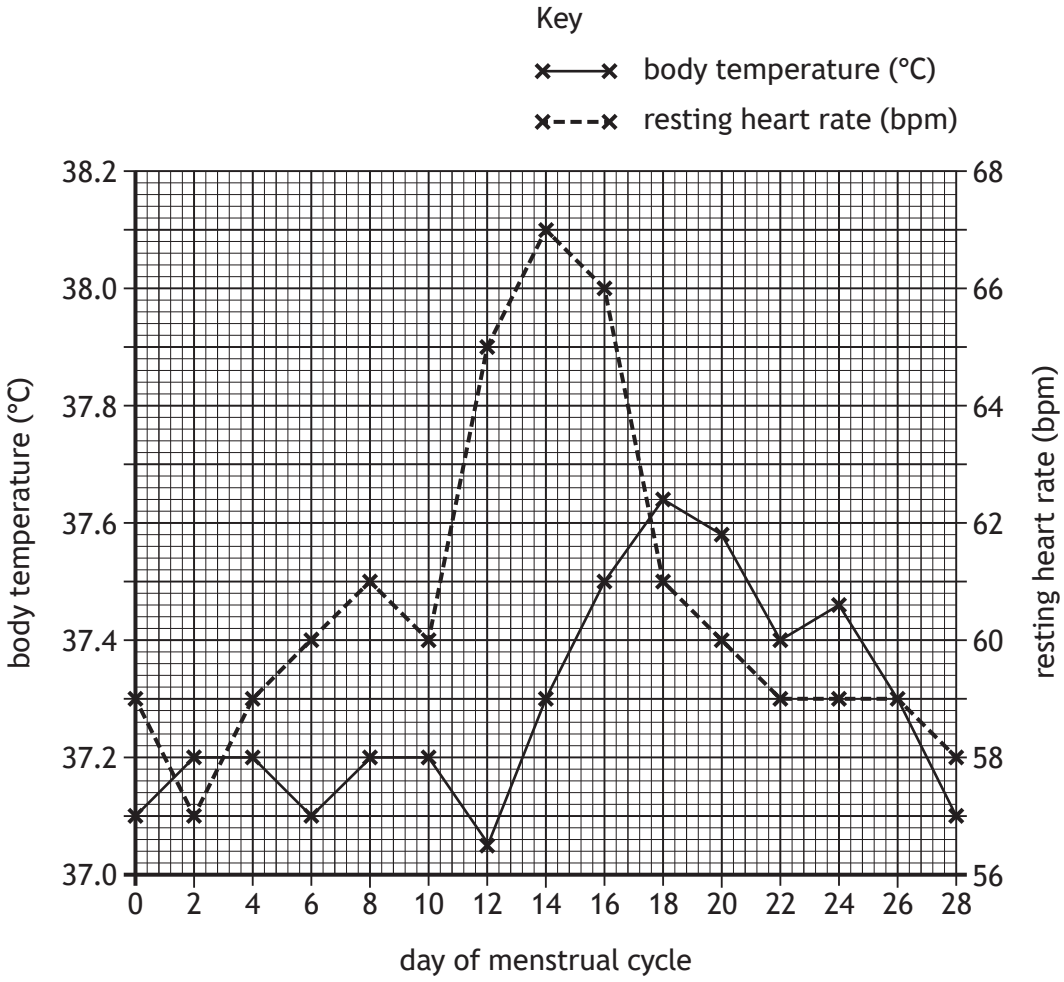
Explain how this type of pill prevents pregnancy. **1**

[Turn over

8. Body temperature and heart rate change during the menstrual cycle.

Graph 1 shows the body temperature and heart rate of a woman during a 28 day menstrual cycle. Readings were taken at the same time every day.

Graph 1



(a) State the body temperature when the resting heart rate was 57 bpm. **1**

_____°C

(b) Calculate the decrease in resting heart rate that occurs between days 14 and 28 of the cycle. **1**

Space for calculation

_____bpm

8. (continued)

(c) (i) Calculate the increase in body temperature that occurs between days 12 and 18 of the cycle. **1**

Space for calculation

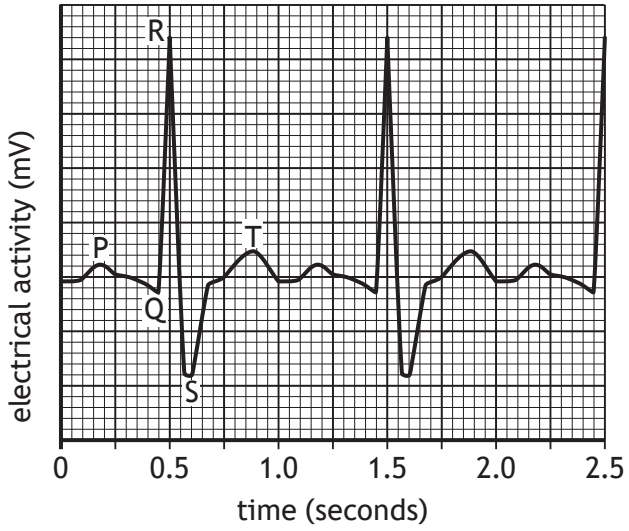
_____°C

(ii) State the event that occurs prior to this increase in body temperature. **1**

_____

(d) **Graph 2** shows an electrocardiogram (ECG) trace of this woman's heartbeat.

Graph 2



(i) Describe what happens to the heart as a result of the electrical activity between Q and S. **1**

_____

(ii) **Use the information in Graph 1 and Graph 2** to determine on how many days this electrocardiogram (ECG) could have been taken. **1**

Space for calculation

_____days

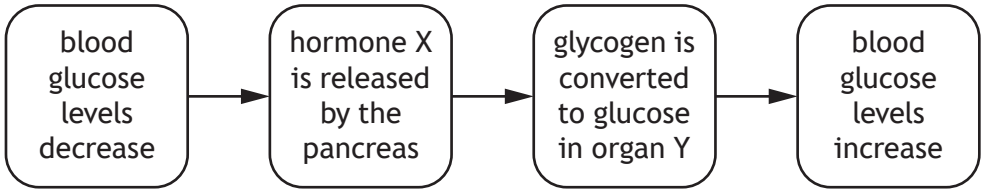
8. (continued)

(e) Women are only fertile for a few days during the menstrual cycle.

Apart from body temperature and heart rate, state one other indicator of a woman's fertile period. **1**

_____

9. The diagram shows part of the hormonal regulation of blood glucose levels.



(a) Name hormone X and organ Y. **2**

Hormone X _____

Organ Y _____

(b) Describe how the glucose tolerance test is carried out and how the results can indicate if an individual has diabetes. **3**

_____

_____

_____

_____

_____

_____

_____

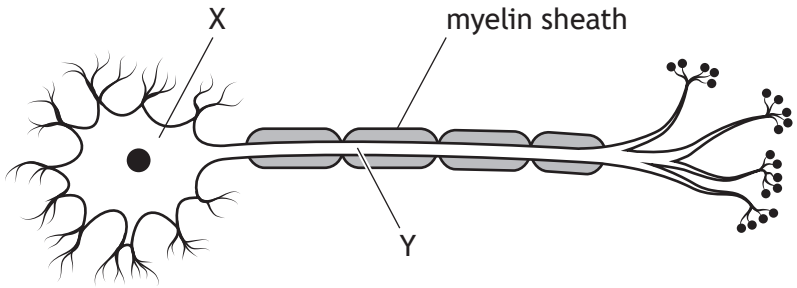
_____

_____

_____

[Turn over

10. The diagram shows a neuron.



(a) Name the parts labelled X and Y. **2**

X _____

Y _____

(b) Neurons connect with other neurons at a synaptic cleft.

(i) State one way that neurotransmitters are removed from a synaptic cleft. **1**

_____

_____

(ii) Explain why neurotransmitters must be removed from a synaptic cleft. **1**

_____

_____

(c) (i) State the function of the myelin sheath. **1**

_____

_____

(ii) Name the type of cells that produce myelin. **1**

_____

10. (continued)

(d) Multiple Sclerosis (MS) is a degenerative disease that leads to the destruction of the myelin sheath.

The table shows the number of cases of MS in males and females in the UK in 2016.

Age (years)	Number of cases (per 100 000)	
	Males	Females
0–14	0	10
15–24	15	20
25–34	70	210
35–44	200	480
45–54	210	590
55–64	270	405
65–74	150	350
75+	80	110

Describe two differences in the trends for the number of cases of MS in males and females. **2**

1. _____

_____

_____

2. _____

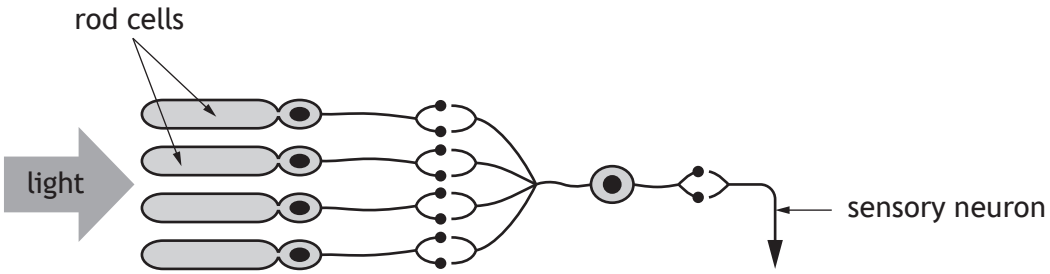
_____

_____

[Turn over

11. The retina in the eye contains specialised receptor cells called rods, that can detect light. These are connected to sensory neurons, which carry impulses out of the eye.

The diagram represents part of a neural pathway in the retina.



(a) Describe the function of sensory neurons. **1**

(b) (i) Use the diagram to explain why this pathway can be described as a converging neural pathway. **1**

(ii) Suggest how this converging arrangement of rod cells increases sensitivity to allow vision in dim light. **2**

(c) A genetic disorder, which does not show sex-linked inheritance, can lead to the gradual loss of rod cells in the retina.

State the location of the allele that causes this genetic disorder. **1**

12. The photograph shows an individual skiing in the mountains.

(a) State how prolonged activities like skiing can affect an individual's endorphin production. **1**

(b) The individual falls and breaks a bone in their leg.

Explain the benefit of endorphin release immediately after the injury. **1**

(c) The injured individual is given an injection of the drug morphine, which acts as an agonist of endorphins.

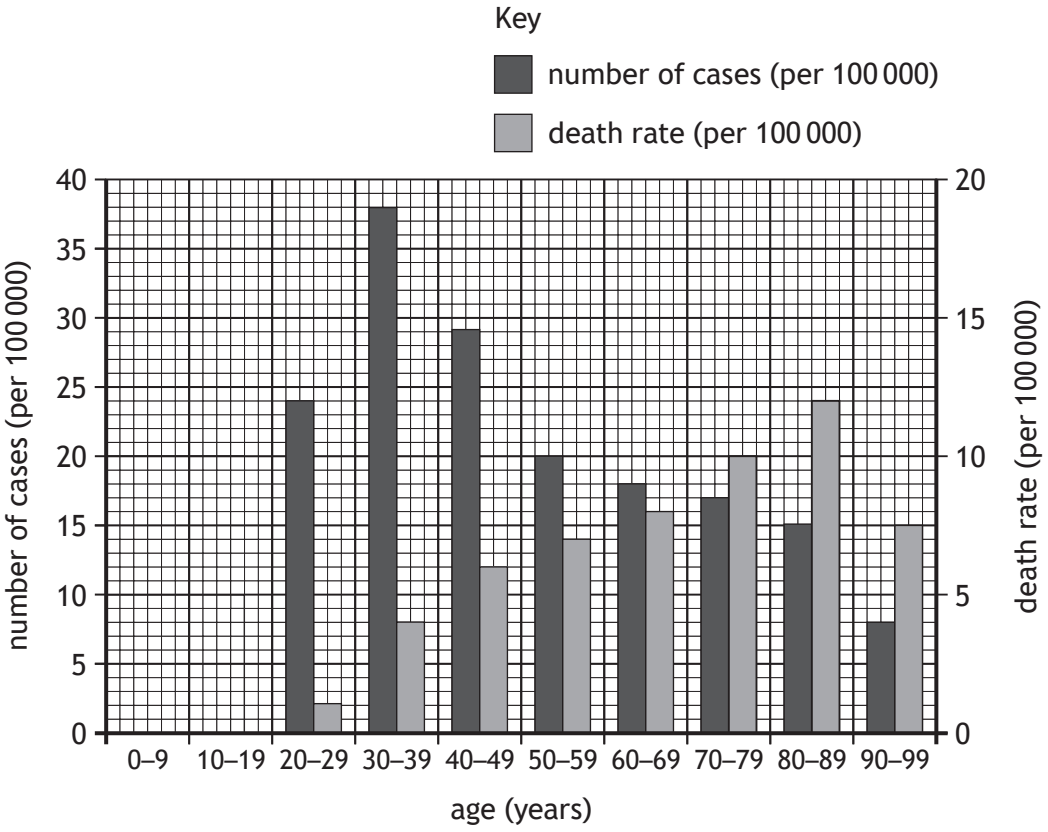
(i) Describe how morphine acts at a synapse to relieve pain. **1**

(ii) Heroin is a recreational drug that is converted to morphine in the body.

Describe how the repeated use of heroin can result in an individual developing a tolerance to it. **1**

[Turn over

13. The graph shows the number of cases of cervical cancer in females of different ages in the UK in one year. It also shows the death rate from cervical cancer at each age.



(a) Use data from the graph to describe changes that occur in the number of cases of cervical cancer from the ages of 20–29 to 90–99. **2**

(b) (i) Calculate the decrease in death rate from 80–89 to 90–99 years. **1**

Space for calculation

_____ per 100 000

13. (b) (continued)

(ii) Suggest a reason for the decrease in the death rate from cervical cancer between ages 80–89 and 90–99. **1**

(c) Express, as a simple whole number ratio, the number of cases compared to death rate at ages 30–39. **1**

Space for calculation

number of cases : death rate

(d) Some females with cervical cancer develop secondary tumours in their body.

Explain how these secondary tumours occur. **1**

(e) The human papilloma virus (HPV) is commonly associated with cases of cervical cancer.

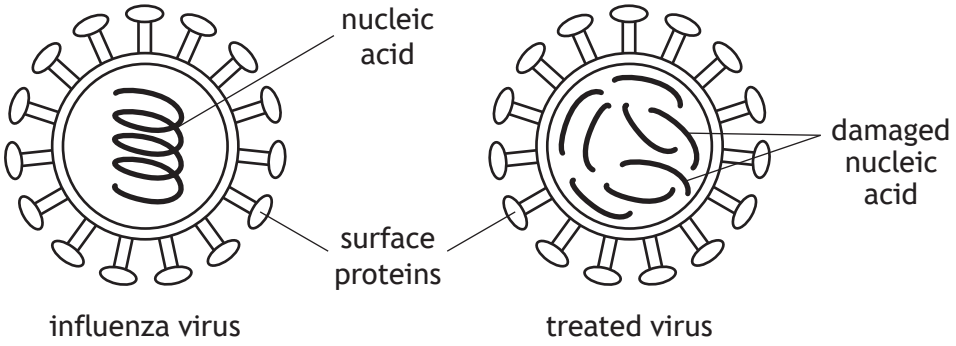
The UK has a vaccination programme against HPV.

Use information from the graph to suggest why females are given the vaccine when they are teenagers. **1**

[Turn over

14. Many people are vaccinated against the influenza virus each year.

(a) The diagram represents the influenza virus and a treated form of the same virus, which is contained in a vaccine.



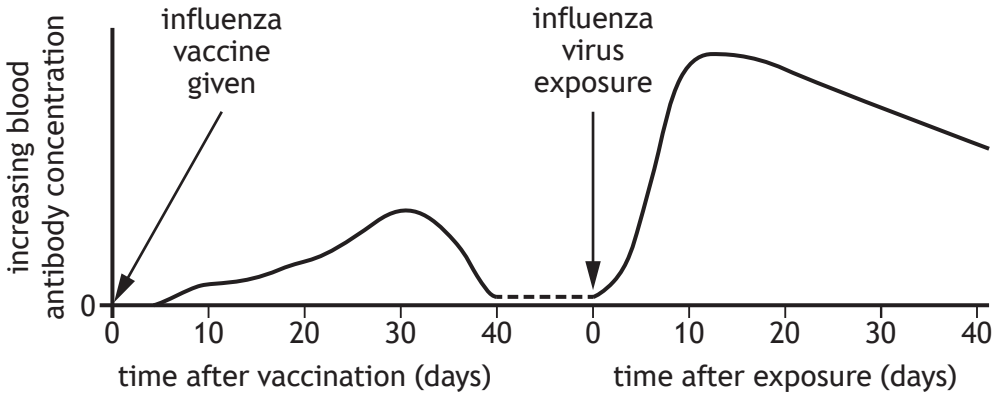
(i) Suggest why the nucleic acid molecule must be damaged in a virus used in a vaccine. **1**

(ii) Explain why the surface proteins of the virus used in the vaccine must remain undamaged. **2**

(iii) Describe why an adjuvant is often added to a vaccine. **1**

14. (continued)

(b) The graph shows the blood antibody concentration of an individual after an influenza vaccination and after exposure to the influenza virus a few weeks later.



(i) The individual produces more antibodies after exposure to the influenza virus than after vaccination.

Use the graph to describe two other ways in which the individual's blood antibody concentration differs after exposure to the influenza virus compared to after vaccination. **2**

1. _____

_____

2. _____

_____

(ii) Describe how memory cells lead to an increase in antibody production after the individual has been exposed to the influenza virus. **1**

_____

_____

[Turn over

14. (continued)

(c) Antibodies inactivate viruses, which are then removed by phagocytosis.

Describe the process of phagocytosis. **2**

MARKS | DO NOT WRITE IN THIS MARGIN

15. Attempt **either** A **or** B. Write your answer in the space below and on *page 30*.

A Discuss the formation of a thrombus and the damaging effects it can cause in the body. **9**

OR

B Discuss the production, transport, and role of cholesterol in the body. **9**

You may use labelled diagrams where appropriate.