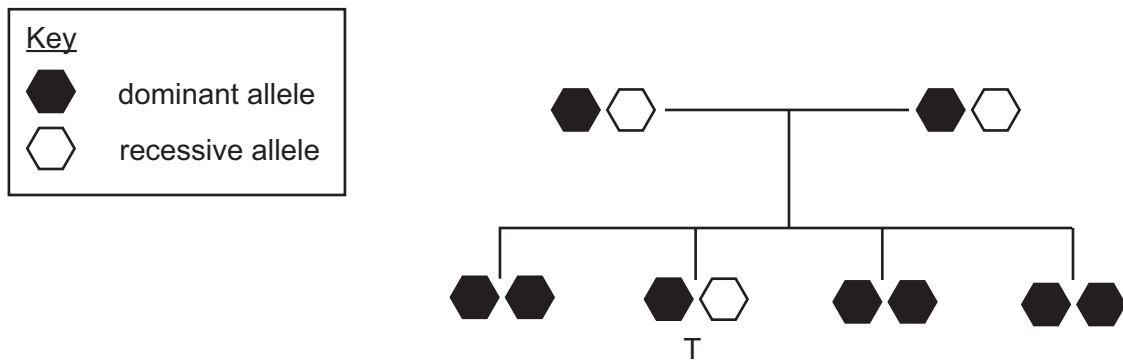


PART Z Biology

- 41 The diagram shows the inheritance of a characteristic controlled by a single gene. Two organisms reproduce sexually and have four offspring, one offspring at a time.



Individual T goes on to have a single offspring with an unrelated individual who has a recessive phenotype. The offspring of T has a dominant phenotype.

What is the ratio of dominant to recessive alleles for all of the individuals in this diagram, as well as T's mate and their one offspring?

- A 3:5
- B 5:3
- C 7:1
- D 1:7
- E 3:1
- F 1:3
- G 2:1
- H 1:2

- 42** The average healthy mature red blood cell contains 200 000 000 molecules of haemoglobin.

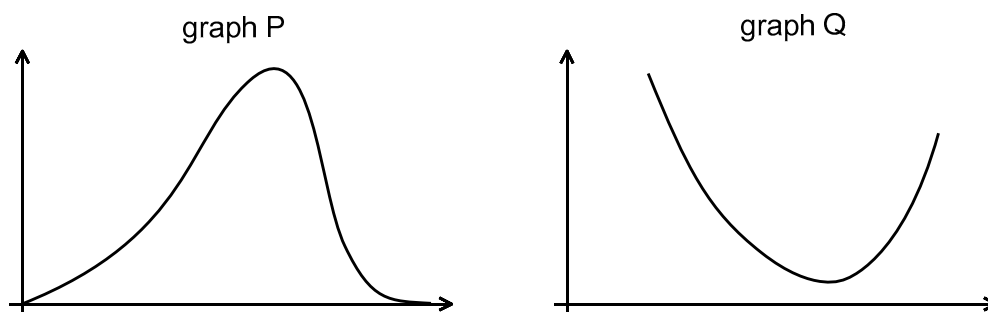
If a red blood cell is saturated with dissolved oxygen, each haemoglobin molecule carries a total of 4 molecules of oxygen.

Haemoglobin molecules in red blood cells in the pulmonary artery are on average 65% saturated with oxygen.

How many oxygen molecules are carried by the average red blood cell in the pulmonary artery, and is the level of oxygen saturation greater in the aorta or the pulmonary artery?

	<i>number of oxygen molecules carried</i>	<i>level of oxygen saturation</i>
A	8.0×10^8	aorta > pulmonary artery
B	8.0×10^8	aorta < pulmonary artery
C	5.2×10^8	aorta > pulmonary artery
D	5.2×10^8	aorta < pulmonary artery
E	2.8×10^8	aorta > pulmonary artery
F	2.8×10^8	aorta < pulmonary artery
G	1.3×10^8	aorta > pulmonary artery
H	1.3×10^8	aorta < pulmonary artery

- 43** Graphs P and Q were plotted using data collected in an investigation into the effect of temperature from 0 to 60 °C on an enzyme-controlled reaction. All other variables were controlled.



Which two rows correctly identify the variables plotted on the horizontal and vertical axes of these graphs?

<i>row</i>	<i>graph</i>	<i>horizontal axis</i>	<i>vertical axis</i>
1	P	temperature	time taken for reaction
2	P	temperature	rate of reaction
3	P	time taken for reaction	temperature
4	P	time taken for reaction	rate of reaction
5	Q	temperature	time taken for reaction
6	Q	temperature	rate of reaction
7	Q	time taken for reaction	temperature
8	Q	time taken for reaction	rate of reaction

- A** 1 and 6
B 1 and 7
C 2 and 5
D 2 and 6
E 3 and 5
F 3 and 8
G 4 and 7
H 4 and 8

- 44** A recessive condition is found within a human population. There were 5000 births in this population within one year. Of these births, 8% had the condition and 32% were homozygous dominant.

One healthy cheek cell is analysed from each person born in this year.

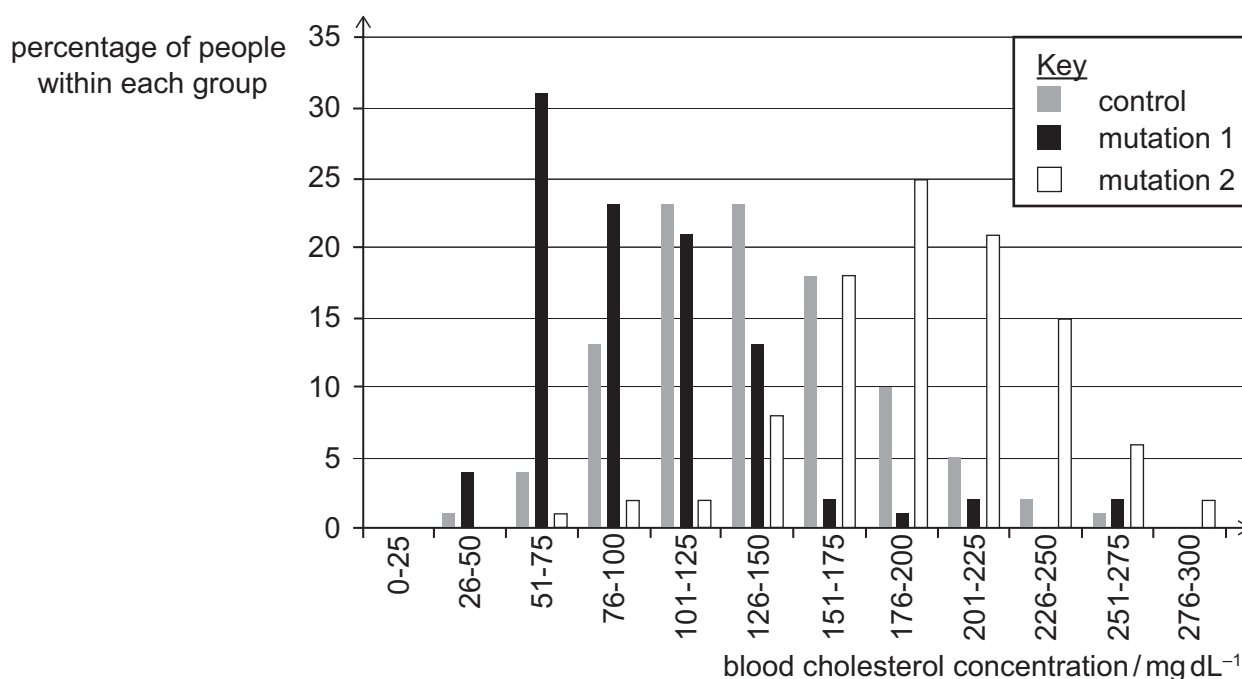
How many recessive alleles and dominant alleles are present?

(Assume that no new mutations occur.)

	<i>recessive alleles</i>	<i>dominant alleles</i>
A	400	1600
B	400	4600
C	3400	1600
D	3400	4600
E	3400	6200
F	3800	1600
G	3800	4600
H	3800	6200

- 45** A study was carried out into the effect of liver protein Z on the risk of developing coronary heart disease, which is often associated with high blood cholesterol. Z binds to another protein in the membrane of liver cells that transports cholesterol from the blood into cells. This binding blocks the function of the transport protein.

Blood cholesterol levels were measured in three different groups of people. One group was a control group and contained no mutations in the gene for Z. The second group all had the same mutation in the gene (called mutation 1). This mutation occurs in the final section of the gene. A third group all had a different mutation in the gene (called mutation 2), but this was in the first section of the gene. The results are shown in the graph.

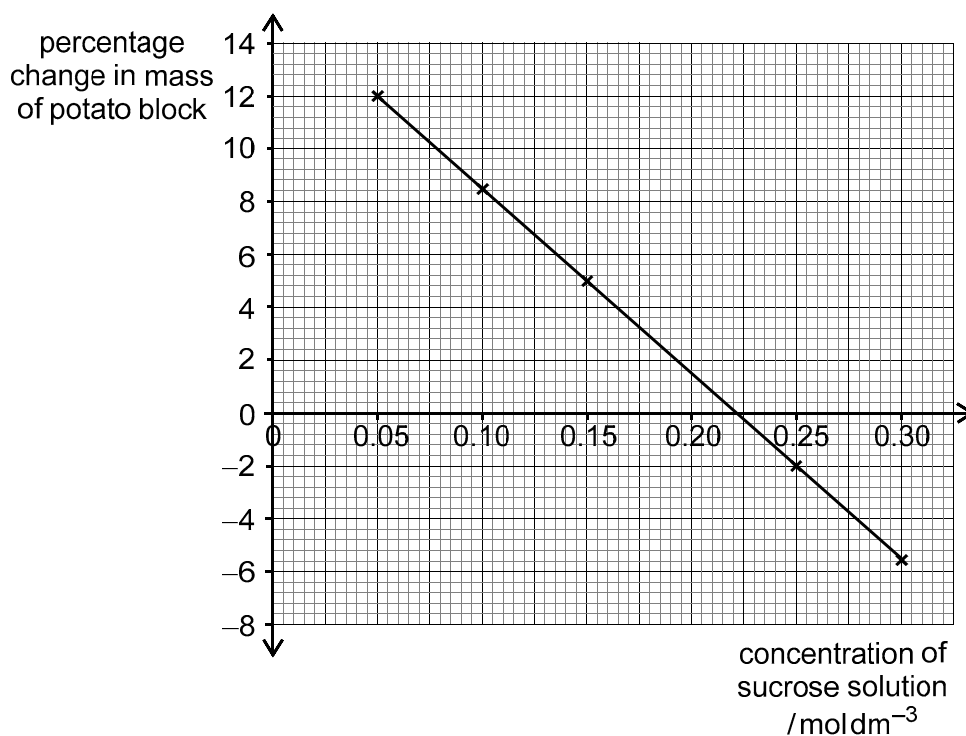


Which of the following can be correctly concluded from these results?

- 1 Changes in the first section of protein Z stop it from binding to the cholesterol transport protein.
 - 2 Mutation 1 could result in an increase in the concentration of cholesterol inside liver cells.
 - 3 Of the three groups, people in the control group are least likely to develop coronary heart disease.
- A** none of them
- B** 1 only
- C** 2 only
- D** 3 only
- E** 1 and 2 only
- F** 1 and 3 only
- G** 2 and 3 only
- H** 1, 2 and 3

- 46** Equal-sized, rectangular blocks of a raw potato were cut and their mass measured. The blocks were then placed in equal volumes of different concentrations of sucrose solutions for the same length of time. All other variables were kept constant.

After this time, the blocks were blotted on paper and then their masses were measured again. The percentage change in mass of each block was calculated and the results are shown in the graph.



Which of the following statements is/are correct?

- 1 In 0.10 mol dm⁻³ sucrose solution, there was some movement of sucrose molecules by osmosis across the membrane out of the potato block.
 - 2 If the initial mass of the block in 0.25 mol dm⁻³ sucrose solution is 1.800 g then its final mass will be 1.764 g.
 - 3 Repeating the experiment at a temperature that was 10°C lower should not affect the point at which the graph crosses the x -axis.
- A** none of them
- B** 1 only
- C** 2 only
- D** 3 only
- E** 1 and 2 only
- F** 1 and 3 only
- G** 2 and 3 only
- H** 1, 2 and 3

- 47 The table shows the sources of water lost in one particular day from a healthy human.

<i>percentage of the water that is lost</i>	<i>source</i>
16	exhaled air
4	faeces
20	sweat
60	urine

On another day, the percentage of water lost in urine decreased by a sixth.

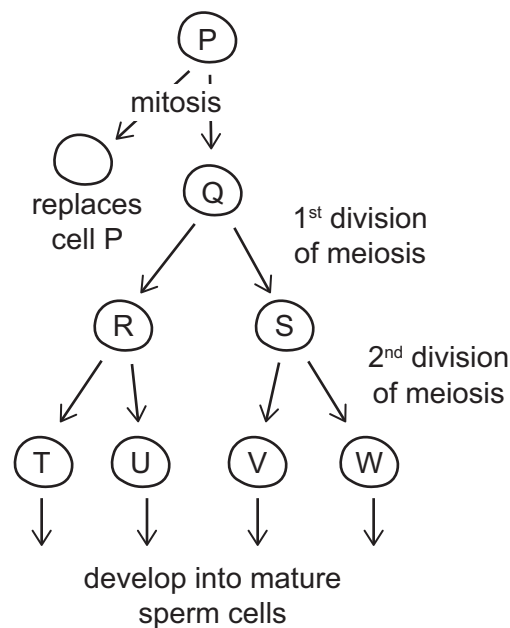
The percentage of water lost in exhaled air and in faeces remained the same.

The total volume of water lost was 2500 cm^3 on both days.

What is the percentage increase in the volume of sweat produced and the reason for the decrease in the volume of urine?

	<i>percentage increase in the volume of sweat</i>	<i>reason for the decrease in the volume of urine</i>
A	33	a decrease in ADH
B	33	an increase in ADH
C	50	a decrease in ADH
D	50	an increase in ADH
E	150	a decrease in ADH
F	150	an increase in ADH

- 48** The diagram shows the production of sperm cells in a healthy mammal. Cell P divides. One daughter cell goes on to replace cell P, and the other daughter cell is called Q in the diagram.



Each mitotic cell cycle takes 14 hours.

The diploid number of chromosomes in this mammal is 68.

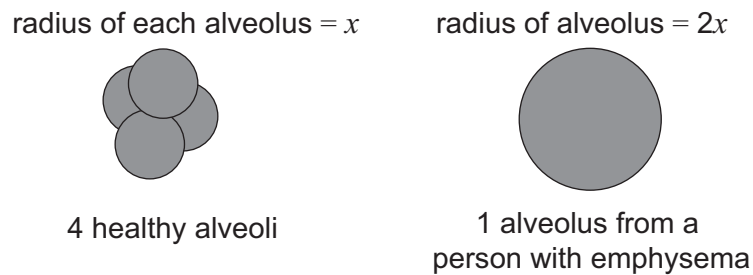
Which of the following statements is/are correct?

- 1 Cell P is a type of stem cell.
- 2 Cells T, U, V and W each contain 23 chromosomes.
- 3 In 112 hours, 128 replacements of cell P are made.

- A** none of them
- B** 1 only
- C** 2 only
- D** 3 only
- E** 1 and 2 only
- F** 1 and 3 only
- G** 2 and 3 only
- H** 1, 2 and 3

- 49** In the disease emphysema the walls of the alveoli break down so that several smaller alveoli fuse to form a single large alveolus.

The diagram shows a model of the effect of emphysema on spherical alveoli.



Which of the following statements is/are correct?

- 1** The surface area-to-volume ratio of the four healthy alveoli is twice that of the single emphysema alveolus.
- 2** For the same concentration gradient, the rate of diffusion of oxygen into the blood from a single healthy alveolus will be greater than for a single emphysema alveolus.
- 3** Oxygen molecules will only move across the alveolus wall from the inside to the outside of an alveolus.

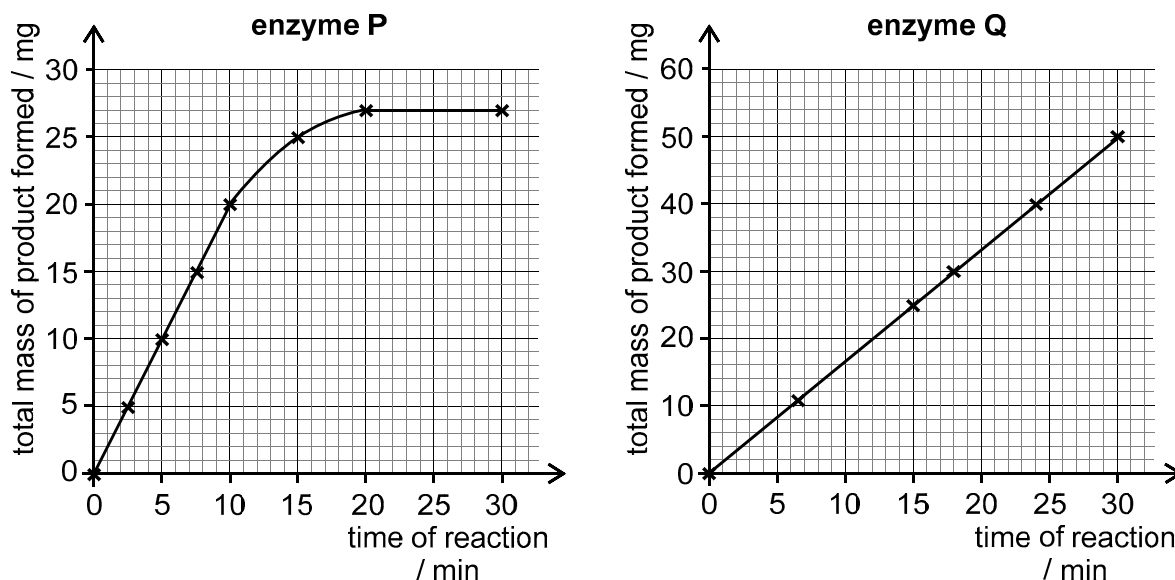
(surface area of a sphere = $4\pi r^2$; volume of a sphere = $\frac{4}{3}\pi r^3$, where r is the radius)

- A** none of them
- B** 1 only
- C** 2 only
- D** 3 only
- E** 1 and 2 only
- F** 1 and 3 only
- G** 2 and 3 only
- H** 1, 2 and 3

- 50** Experiments were carried out to investigate the rate at which products were formed by two digestive enzymes, P and Q over a period of 30 minutes.

P and Q have similar optimum conditions for function. Only the enzyme and its substrate were changed between each reaction.

The results are shown in the graphs.

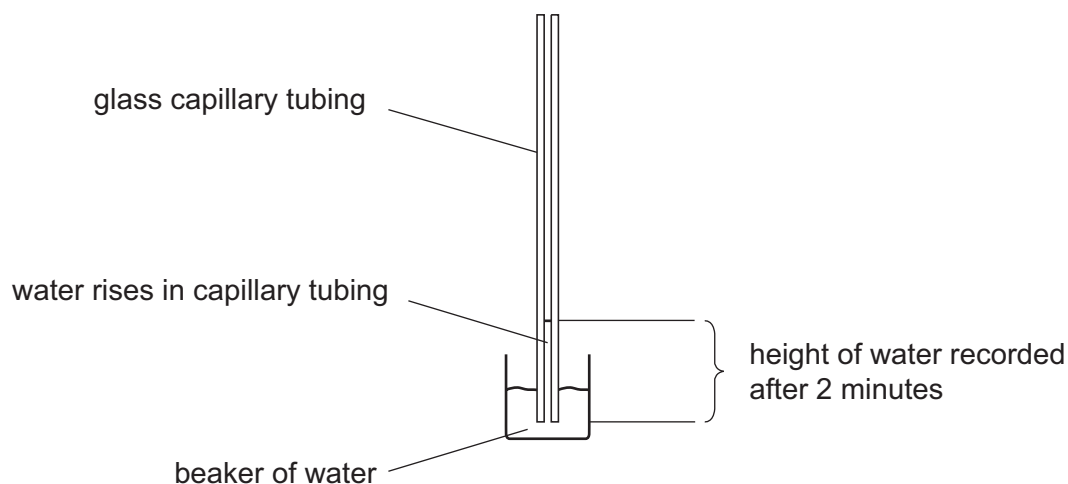


Which of the following statements is/are correct?

- 1** During the first 10 minutes, the rate of reaction (mg min^{-1}) with enzyme P is double the rate with enzyme Q.
 - 2** A possible explanation for the difference in the shape between the graphs is that the product of the reaction catalysed by P significantly alters the pH of the solution.
 - 3** The percentage change in mass of product formed by enzyme Q is more than 5 times greater between 6.5 and 15 minutes than it is between 24 and 29 minutes.
- A** none of them
- B** 1 only
- C** 2 only
- D** 3 only
- E** 1 and 2 only
- F** 1 and 3 only
- G** 2 and 3 only
- H** 1, 2 and 3

- 51** An experiment was performed to investigate whether capillary action could account for the movement of water from roots to leaves in a plant.

The diagram shows apparatus used to model this effect using narrow glass capillary tubing. The inner diameter of the capillary tubing is 0.5 mm.



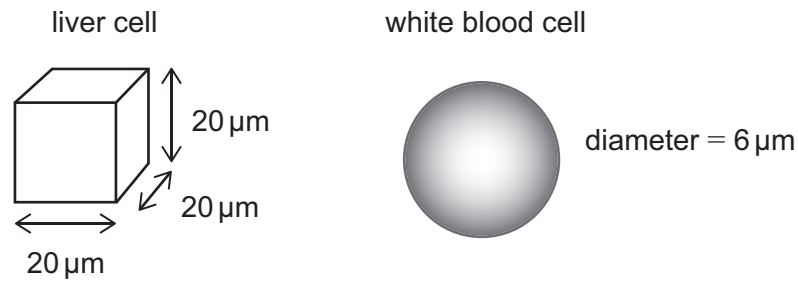
The initial height of the water in the tubing was recorded as 0.2 cm. After 2 minutes the height was recorded as 1.8 cm.

The model assumes the rate of movement is constant.

What is the rate of water movement in $\text{mm}^3 \text{min}^{-1}$ and what vessel type transfers water from roots to leaves in a real plant?

	<i>rate of water movement / $\text{mm}^3 \text{min}^{-1}$</i>	<i>vessel type</i>
A	0.5π	xylem
B	0.5π	phloem
C	π	xylem
D	π	phloem
E	2π	xylem
F	2π	phloem
G	4π	xylem
H	4π	phloem

- 52** Two healthy human cells with no mutations were modelled as shown in the diagrams below. The cells were not dividing. Both cells contain a single nucleus and are diploid.



[diagram not to scale]

A study estimates that mitochondria account for 12% of the volume of both types of cells.

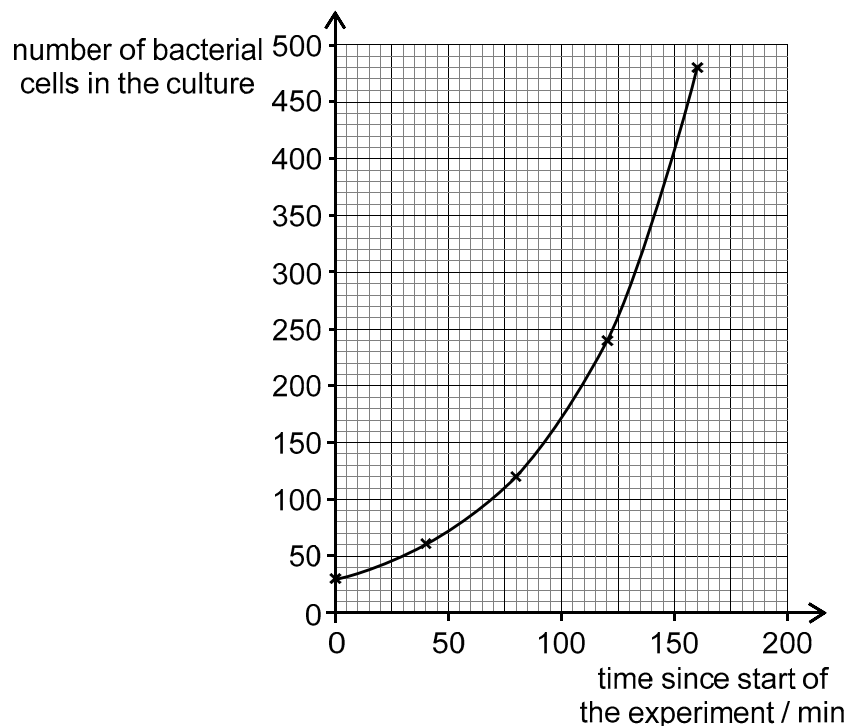
Using this estimate for all cells, which of the following is/are correct?

(The volume of a sphere is given by $\frac{4}{3}\pi r^3$, where r is the radius. Use the value 3.14 for π)

- 1** The larger number of mitochondria in the liver cell will produce more lactic acid than those in the white blood cell.
 - 2** The liver cell is larger and so will contain a greater mass of nuclear DNA than the white blood cell.
 - 3** The mitochondria in the white blood cell occupy $14\ \mu\text{m}^3$ to the nearest whole number.
- A** none of them
- B** 1 only
- C** 2 only
- D** 3 only
- E** 1 and 2 only
- F** 1 and 3 only
- G** 2 and 3 only
- H** 1, 2 and 3

- 53** Bacterial cells were grown in a laboratory experiment and the number of cells was recorded at regular intervals. The bacteria in this experiment reproduced asexually using a form of cell division. The growth medium was sterilised before it was used and the vessel containing the bacterial cells was sealed so that no other cells could enter.

The graph shows the results of the experiment.



Which of the following statements is/are correct?

- 1** After 4 hours, assuming that the rate of growth continues on the same curve, the predicted number of cells in the experiment is 1920.
 - 2** During the 80 minutes after the start of the experiment there was a 400% increase in the number of cells.
 - 3** The growth curve is of the form $y = 30k^x$
- A** none of them
- B** 1 only
- C** 2 only
- D** 3 only
- E** 1 and 2 only
- F** 1 and 3 only
- G** 2 and 3 only
- H** 1, 2 and 3

- 54** Three samples of cells were taken from the same healthy human: one sample from the blood, one sample from a kidney, and one sample from a testis.

Each sample contained five cells, three of one type and two of a different type. None of the cells were dividing.

In each sample, the mean number of chromosomes per cell was calculated. The results are shown in the table.

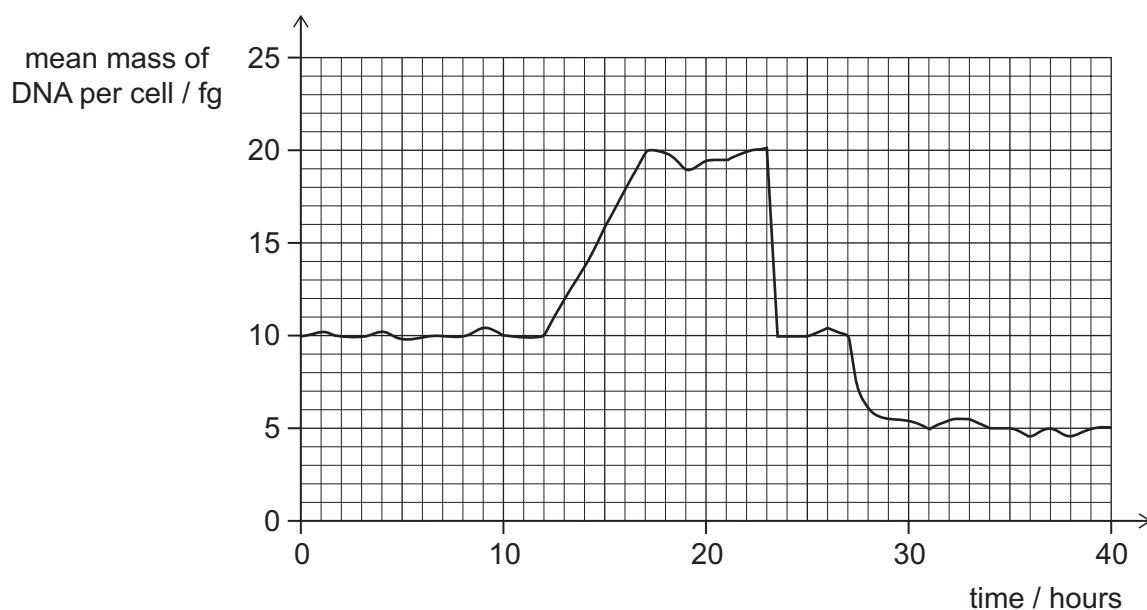
<i>sample</i>	<i>mean number of chromosomes per cell</i>
1	18.4
2	32.2
3	46.0

Which row in the following table identifies the samples from the kidney and the testis?

(Assume that no mutations occur in any of the cells in the samples.)

	<i>kidney</i>	<i>testis</i>
A	1	2
B	1	3
C	2	1
D	2	3
E	3	1
F	3	2

- 55** The graph shows the mean mass of DNA of a population of cells dividing at the same time, measured in femtograms (10^{-15} g) per cell.

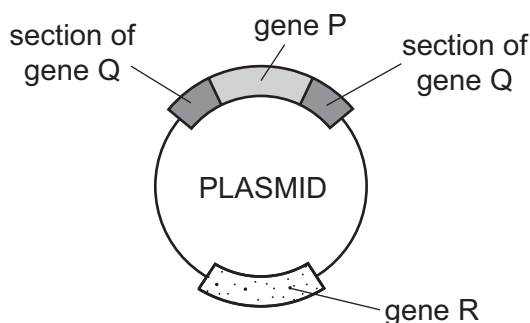


Which row in the table is correct?

	<i>type of cell division taking place</i>	<i>rate of DNA synthesis per cell between 12 and 17 hours / fg h⁻¹</i>	<i>period that could be part of interphase</i>
A	meiosis	2	0 to 17 hours
B	meiosis	0.5	0 to 17 hours
C	meiosis	2	12 to 24 hours
D	meiosis	0.5	12 to 24 hours
E	mitosis	2	0 to 17 hours
F	mitosis	0.5	0 to 17 hours
G	mitosis	2	12 to 24 hours
H	mitosis	0.5	12 to 24 hours

- 56** A plasmid contains genes Q and R. Gene Q codes for resistance to the antibiotic *q*. Gene R codes for resistance to antibiotic *r*.

The plasmid was genetically engineered to contain the human gene P. This gene was inserted into gene Q in the plasmid preventing gene Q from working.



A mixture of the original plasmid and the genetically-engineered plasmid were available to be taken up by bacterial cells. The bacterial cells took up either the original plasmid, or the genetically-engineered plasmid, or neither of the plasmids.

All these bacteria were allowed to grow and form colonies on agar plates in the absence of both antibiotics.

40 colonies formed.

Cells from each of the 40 colonies were grown on three agar plates with different contents.

The table shows the number of colonies that grew on each of the three plates.

<i>contents of agar plate</i>	<i>number of bacterial colonies able to survive on the agar plate</i>
no antibiotic	40
antibiotic <i>q</i> only	8
antibiotic <i>r</i> only	24

What percentage of the original 40 bacteria now contain gene P?

(Assume that no mutations occur.)

- A** 16%
- B** 20%
- C** 33%
- D** 40%
- E** 60%
- F** 80%