

# Dalkeith High School



## CfE Higher Human Biology

### Unit 1

### Human Cells

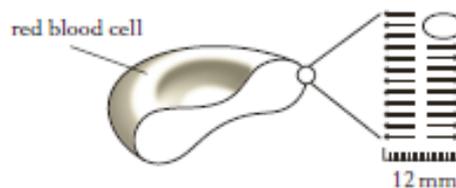
### Past Paper Questions

## Division and Differentiation -

- Which of the following is **not** a use of stem cells?
  - Skin grafts
  - Drug testing
  - IVF treatment
  - Bone marrow transplant
- Which line in the table below describes correctly cell division in a specific cell type?

	Cell type	Type of cell division	Chromosome number in cells produced
A	somatic	meiosis	diploid
B	somatic	meiosis	haploid
C	germline	mitosis	haploid
D	germline	mitosis	diploid

- Stem cells in the bone marrow give rise to
  - Only platelets
  - Only red blood cells
  - Only platelets and red blood cells
  - Platelets, red blood cells and white blood cells.
- The diagram below represents part of the plasma membrane of a red blood cell.



The membrane is shown magnified 2 million times.  
What is the width of the membrane?  
(1 nanometre =  $1 \times 10^{-6}$ mm)

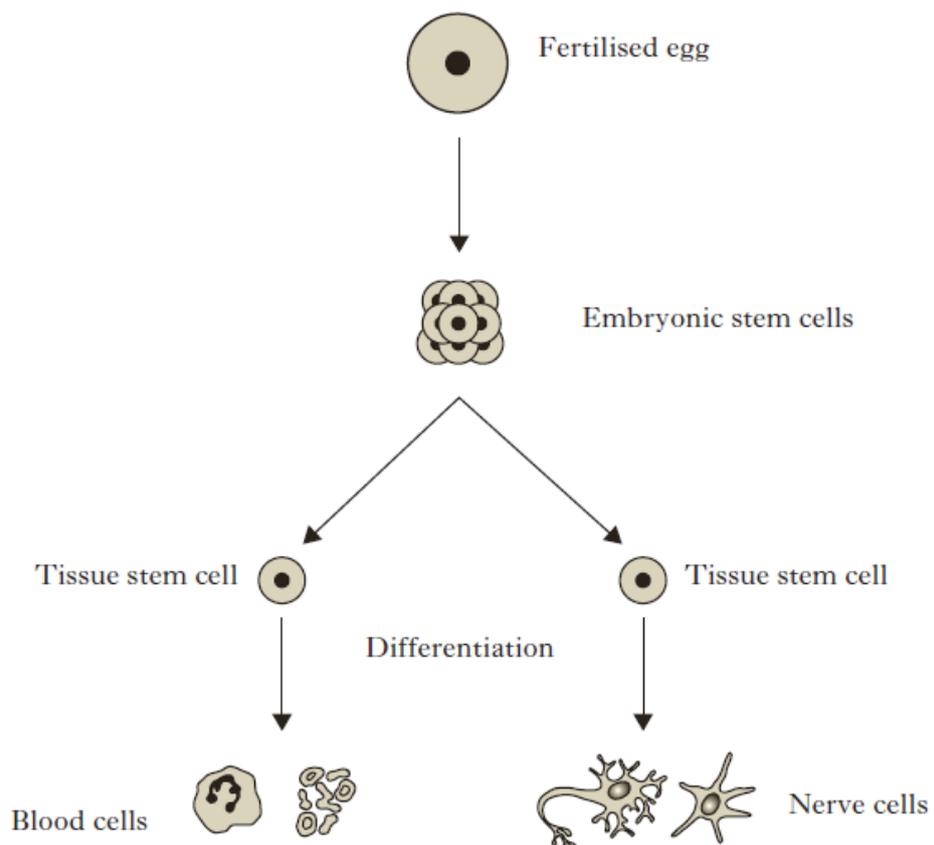
- 0.6 nanometres
- 6 nanometres
- 24 nanometres
- 60 nanometres

5. Which line in the table below matches correctly the cell types with the tissue in which they are found?

	Connective tissue	Epithelial tissue
A	Blood cell	Skin cell
B	Bone cell	Nerve cell
C	Cartilage cell	Bone cell
D	Muscle cell	Cartilage cell

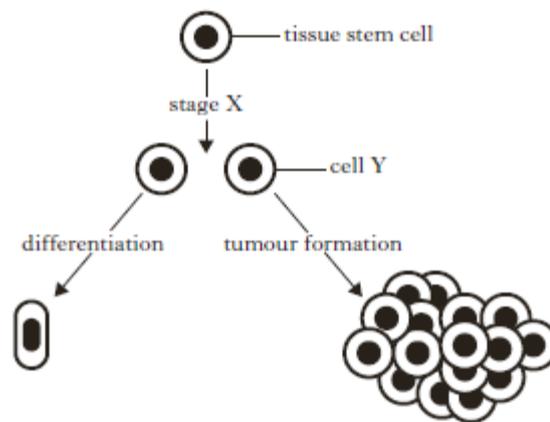
6. Stem cells in the red bone marrow
- Are already differentiated
  - Can differentiate into all cell types
  - Can only differentiate into bone cells
  - Can differentiate into platelets and lymphocytes

7. The diagram below shows some stages in the development of blood cells and nerve cells.



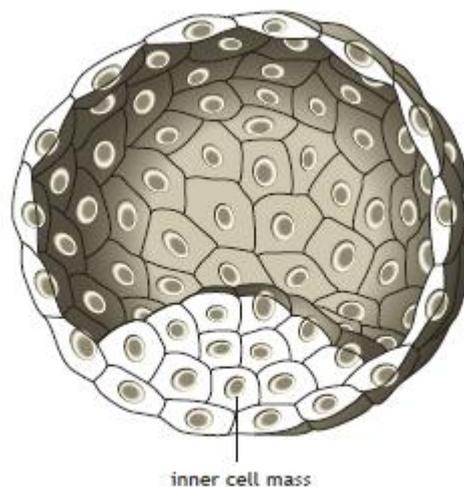
- What are stem cells? (1)
- State the location of the tissue stem cells which develop into blood cells. (1)
- Describe what is meant by differentiation. (1)
- Both embryonic stem cells and tissue stem cells are used in medical research. Give one reason why embryonic stem cells are potentially more useful than tissue stem cells. (1)

8. The diagram below shows two possible pathways involving tissue stem cells.



- a. Name the type of cell division occurring during stage X. (1)
- b. Describe what happens to the genes of a cell as differentiation occurs. (1)
- c. i) Explain what happens to cell Y, which leads to the formation of a tumour. (2)
- ii) Describe how secondary tumours can arise from a tumour. (1)
- d. Describe a therapeutic use of stem cells. (1)

9. The diagram below represents an embryo in the early stages of development and identifies the inner cell mass which is made up of stem cells.



- a. State one feature of stems cells. (1)
- b. Stem cells are also found on tissues throughout the adult body.  
Explain how the function of tissue stem cells differs from that of the stem cells found in the inner cell mass of an embryo. (1)
- c. Stem cells have uses both in therapy and research.
  - i) It has been proposed that tissue cells could be used to repair severely damaged muscle tissue.  
Suggest how this might be done. (1)
  - ii) State how stem cells can be used as model cells in medical research. (1)

## Structure and Replication of DNA

10. A DNA molecule consists of 4000 nucleotides of which 20% contain the base adenine. How many of the nucleotides in this DNA molecule will contain guanine?
- A. 800
  - B. 1000
  - C. 1200
  - D. 1600
11. A fragment of DNA was found to have 120 guanine bases and 60 adenine bases. What is the total number of sugar molecules in this fragment?
- A. 60
  - B. 90
  - C. 180
  - D. 360
12. How many adenine molecules are present in a DNA molecule of 2000 bases, if 20% of the base molecules are cytosine?
- A. 200
  - B. 300
  - C. 400
  - D. 600
13. DNA controls the activities of a cell for the production of
- A. Proteins
  - B. Carbohydrates
  - C. amino acids
  - D. bases.
14. Thirty percent of bases in a DNA molecule are adenine. The percentage of cytosine bases in the same molecule is
- A. 20%
  - B. 30%
  - C. 40%
  - D. 70%
15. A DNA nucleotide could be formed from a molecule of phosphate together with
- A. ribose sugar and guanine
  - B. ribose sugar and uracil
  - C. deoxyribose sugar and guanine
  - D. deoxyribose sugar and uracil.

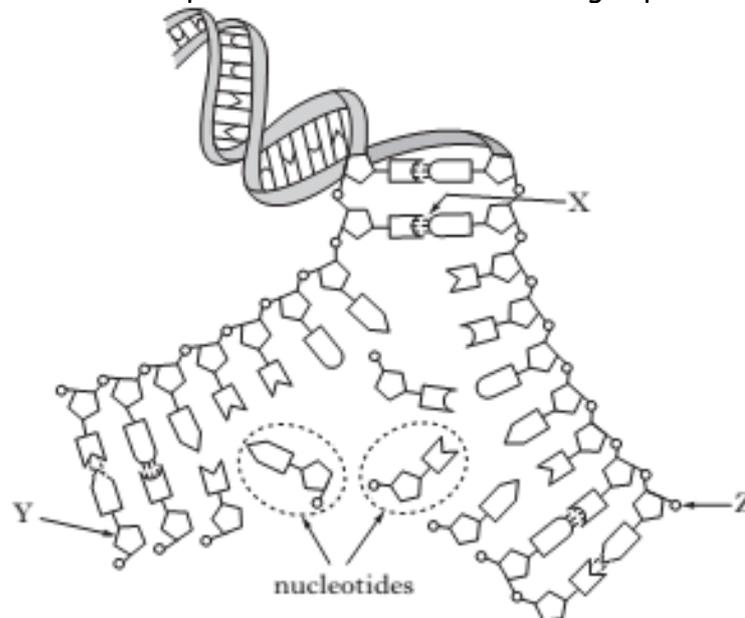
16. If a DNA molecule contains 8000 nucleotides of which 20% are adenine, then the number of guanine nucleotides present is

- A. 1600
- B. 2000
- C. 2400
- D. 3200.

17. During DNA replication, new nucleotides are added to the DNA strand at the

- A. 3' phosphate end
- B. 3' deoxyribose end
- C. 5' phosphate end
- D. 5' deoxyribose end

18. The diagram below shows part of a DNA molecule during replication.



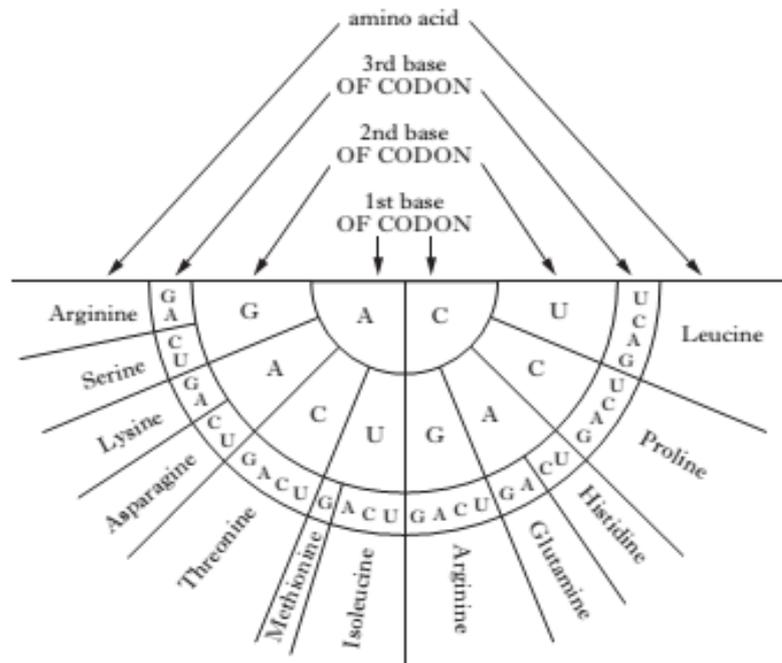
- a. i) During replication, bonds between the two DNA strands are broken. Name the type of bond labelled X. (1)
- ii) Identify the molecules labelled Y and Z. (1)
- iii) Name two molecules not shown on the diagram which are essential for DNA replication. (1)
- b. Explain why DNA replication must take place before a cell divides. (1)

19. Give an account of DNA under the following headings:

- i) DNA structure; (6)
- ii) DNA replication. (4)

## Gene Expression

20. A primary transcript is a strand of
- RNA comprising just exons
  - DNA comprising just exons
  - RNA comprising introns and exons
  - DNA comprising introns and exons
21. The diagram below can be used to identify amino acids coded for by mRNA codons.



How many different amino acids are coded for by the following mRNA strand?

A U G C C A A C U C C U A G A C G A A U A

- 4
  - 5
  - 6
  - 7
22. Which of the following is a possible anticodon found on a tRNA molecule?
- GGG
  - TTT
  - ATC
  - GTU

23. The table below contains statements which may be **True** or **False** with regard to DNA replication and mRNA synthesis.

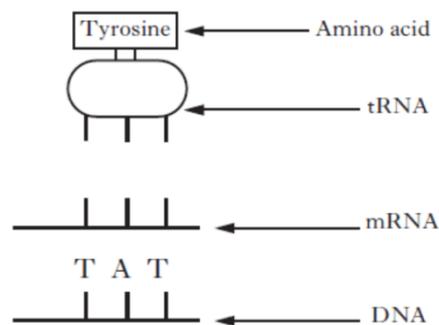
Which line in the table is correct?

	<i>Statement</i>	<i>DNA Replication</i>	<i>mRNA synthesis</i>
A	Occurs in the nucleus	True	False
B	Involved in protein synthesis	True	True
C	Requires free nucleotides	True	False
D	Involves specific base pairing	True	True

24. During the manufacture of protein in a cell, the synthesis of mRNA occurs in the

- A. Nucleus
- B. Ribosomes
- C. Golgi body
- D. endoplasmic reticulum.

25. The following diagram shows some stages in the synthesis of part of a polypeptide.



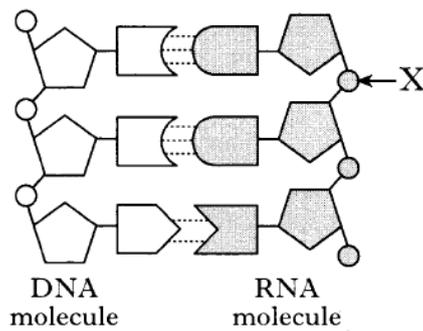
Identify the triplet codes for the amino acid tyrosine.

	On mRNA	On tRNA
A	ATA	UAU
B	UAU	AUA
C	AUA	UAU
D	ATA	TAT

26. The function of tRNA in cell metabolism is to

- A. transport amino acids to be used in synthesis
- B. carry codons to the ribosomes
- C. synthesise proteins
- D. transcribe the DNA code.

27. The diagram represents part of a molecule of DNA on which a molecule of RNA is being synthesised.



What does component X represent?

- A. Ribose sugar
- B. Deoxyribose sugar
- C. Phosphate
- D. Ribose phosphate

28. DNA controls the activities of a cell by coding for the production of

- A. Proteins
- B. Carbohydrates
- C. Amino acids
- D. Bases

29. The following information refers to protein synthesis.

<i>tRNA anticodon</i>	<i>amino acid carried by tRNA</i>
G U G	Histidine (his)
C G U	Alanine (ala)
G C A	Arginine (arg)
A U G	Tyrosine (tyr)
U A C	Methionine (met)
U G U	Threonine (thr)

What order of amino acids would be synthesised from the base sequence of DNA shown?

*Base sequence of DNA*

C G T T A C G T G

- A. arg - tyr - his
- B. ala - met - his
- C. ala - tyr - his
- D. arg - tyr - thr

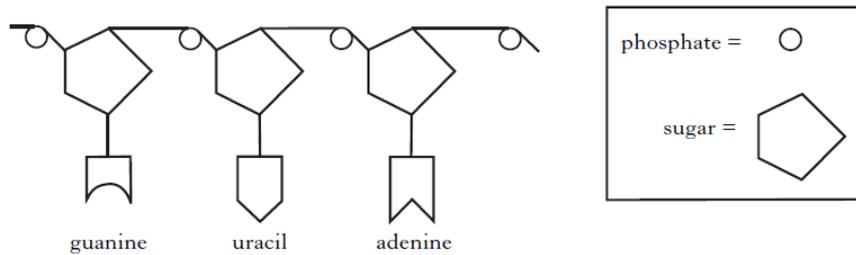
30. A section of DNA has the following base sequence.



Identify the anticodons if the three tRNA molecules which would align with the mRNA molecule transcribed from this section of DNA.

- A. AAU CGC UUC
- B. AAT CGC TTC
- C. TTA GCG AAG
- D. UUA GCG AAG

31. a) The diagram below shows a section of a messenger RNA (mRNA) molecule.

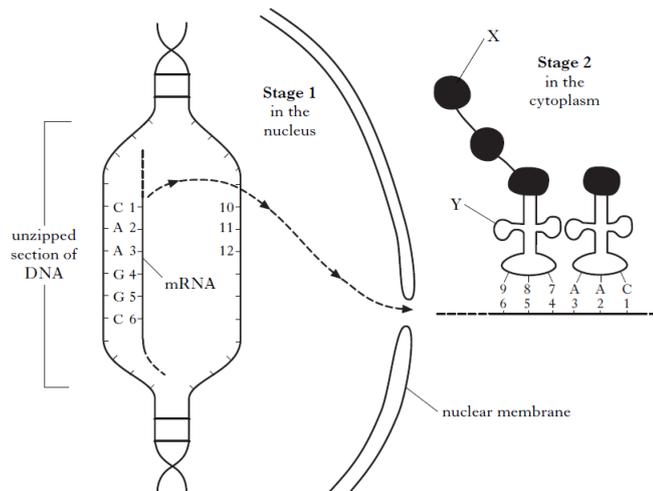


- i) Name the sugar that is present in mRNA (1)
  - ii) Which base found in mRNA is not shown in the diagram? (1)
  - iii) Name two parts of a cell where mRNA is found. (1)
- b) DNA templates are used to produce mRNA molecules. (1)
- i) Insert the name of the DNA bases which pair with the RNA bases shown in the table. (1)

DNA base	RNA base
	Adenine
	Uracil
	Guanine

- ii) Apart from free nucleotides and a DNA template, name one other molecule that is essential for mRNA synthesis. (1)
- iii) Describe the part played by an mRNA molecule in the manufacture of a cell protein. (3)

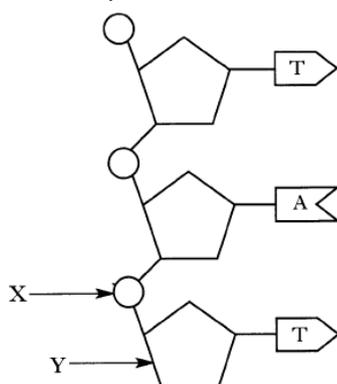
32. The diagram below illustrates the two main stages of protein synthesis.



- a. Describe **three** differences between DNA and mRNA. (2)
- b. Name bases 3, 8 and 11. (2)
- c. Copy the diagram and circle a codon. (1)
- d. Where in the cytoplasm does stage 2 take place? (1)
- e. Name molecules X and Y. (1)

- f. The newly synthesised protein may be secreted from the cell.
- Name the cell structure where the protein would be found just before it enters a secretory vesicle. (1)
  - Describe what happens to the protein while it is in this cell structure. (1)

33. The diagram below shows part of a DNA molecule.



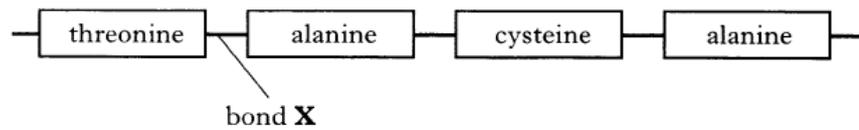
- Copy the diagram and draw a circle around one nucleotide. (1)
  - Name parts X and Y. (1)
- Name the two DNA bases not shown in the diagram. (1)
- State the mRNA codon which would be formed from the triplet of DNA bases shown. (1)
  - Apart from nucleotides, name another molecule needed for the synthesis of mRNA. (1)
- A DNA molecule was found to contain 15000 nucleotides. What is the maximum number of amino acids which could be coded for by this molecule? (1)

34.

- a. Complete the table below to show the mRNA codons and tRNA anticodons for each amino acid. (1)

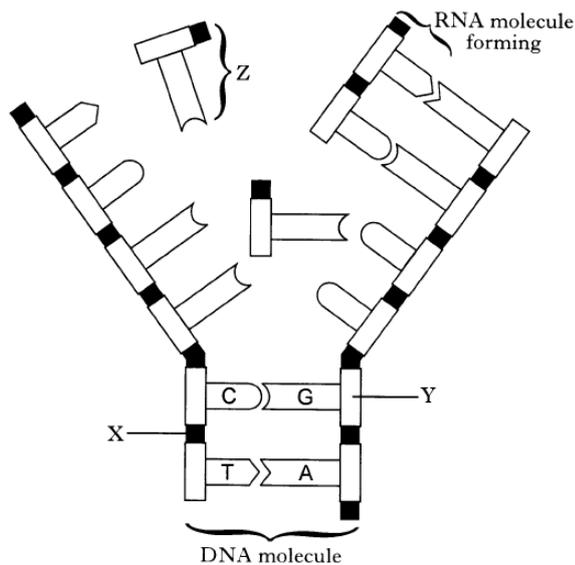
<i>Amino acid</i>	<i>mRNA codons</i>	<i>tRNA anticodons</i>
Alanine		CGA
Threonine	ACC	
cysteine		ACA

- b. The diagram shows the primary structure of part of a protein molecule.



- i) Use the information from the table above to determine the DNA base sequence which would code for this molecule. (1)
- ii) Name bond X. (1)
- iii) Describe one way in which the secondary structure of a protein differs from the primary structure. (1)
- c) Where in the cell are proteins packaged and prepared immediately before secretion. (1)

35. The diagram below represents the process of RNA synthesis.



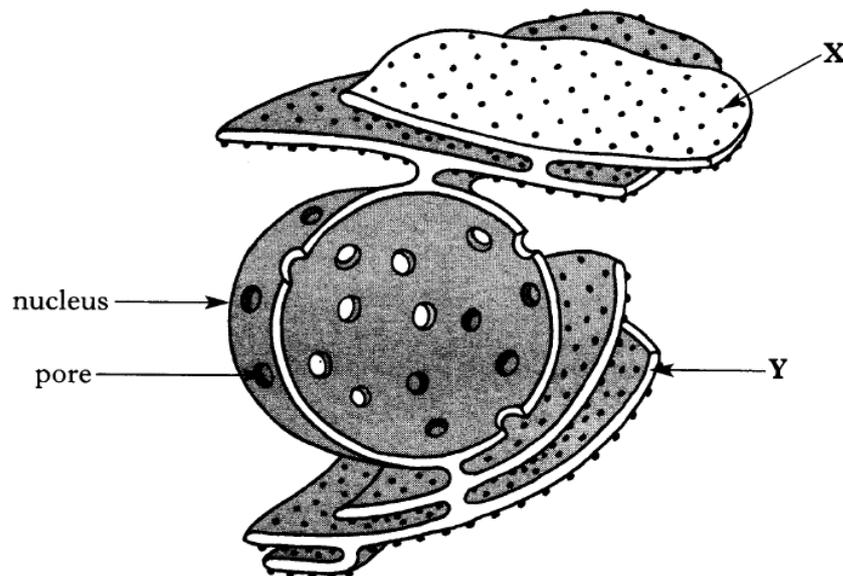
- a. Where in the cell does this process take place? (1)
- b. Name the components X, Y and Z. (1)

- c. State the full names of any **two** different RNA bases shown in the diagram. (1)
- d. Name another substance, **not** shown in the diagram, which is essential for RNA synthesis. (1)
- e. i) What name is given to the triplets of bases in an mRNA molecule? (1)
- ii) The table below shows some amino acids and the triplets of bases specific to them.

Amino acid	Triplet of mRNA bases
Alanine	GCU
Arginine	CGA
Serine	UCG
Histidine	CAC
Valine	GUG

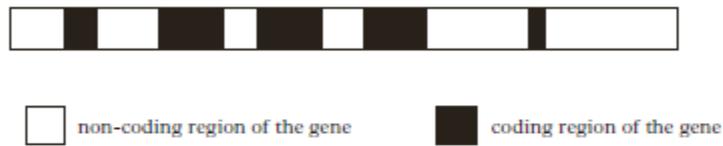
Name the two amino acids that would be specified by the mRNA molecule forming on the DNA strand in the diagram. (1)

36. The diagram below shows a section through a nucleus and associated cell structures.



- a)i) Name organelle X. (1)
- ii) What type of substance is manufactured by organelle X? (1)
- iii) Give an example of such a substance (1)
- b)i) The structure labelled Y is composed of sheets of membranes. What name is given to this structure? (1)
- ii) Structure Y can transport substances to another organelles within the cell. Give an example of such an organelle and state its function. (2)
- d) Why is it necessary to have pores in the nuclear membrane? (1)

37. The diagram below shows one gene within a chromosome.



- State what non-coding regions of a gene are called. (1)
- Explain why it is important that non-coding regions are removed from the primary transcript of this gene before translation. (1)
- The diagram below shows part of one coding region of the mRNA from this gene.



- How many different types of amino acid are coded for by this region of the mRNA strand? (1)
- Describe two ways in which the structure of a molecule of mRNA differs from that of DNA. (2)
  - The following table shows the number of differences in the amino acids sequence for haemoglobin from three animals compared to that of human haemoglobin.

The number of differences gives an indication of evolutionary relationships between species.

<i>Animal</i>	<i>Number of differences in the haemoglobin amino acid sequence compared to human haemoglobin</i>
Frog	67
Mouse	27
Dog	32

Which of these animal's haemoglobin is most closely related to human haemoglobin? (1)

- What term describes all the DNA of a species? (1)

38. Describe how proteins are assembled from the code on an mRNA strand. (8)

39. Describe protein synthesis under the following headings:

- Events that occur in the nucleus (4)
- Events that occur at the ribosome (6)

## Genes and Proteins in Health and Disease

40. A substitution mutation results in a triplet of bases TTC being changed to TCC. The amino acid lysine is coded for by TTC and arginine by TCC. The effect of such a mutation on the resultant protein would be that

- A. arginine replaces lysine throughout the protein
- B. arginine replaces lysine at one position in the protein
- C. lysine replaces arginine throughout the protein
- D. lysine replaces arginine at one position in the protein.

41. The following are descriptions of three single gene mutations.

Description 1: exon-intron codons are created or destroyed

Description 2: one amino acid codon is replaced with another

Description 3: one amino acid codon is replaced with a stop codon

Which line in the table below matches the descriptions with the correct gene mutation?

	Gene mutation		
	Missense	Nonsense	Splice site
A	1	2	3
B	1	3	2
C	2	1	3
D	2	3	1

42. The base sequence of a short piece of DNA is shown below.

  A  G  C  T  T  A  C  G  

During replication, an inversion mutation occurred on the complementary strand synthesised on this piece of DNA.

Which of the following is the mutated complementary strand?

- a.   T  C  G  A  A  T  G  A
- b.   A  G  C  T  T  A  G  C
- c.   T  C  G  A  A  T  C  G
- d.   T  C  G  A  A  T  G  C

43. Which type of gene mutation occurs when a codon of an amino acid is replaced with a stop codon?

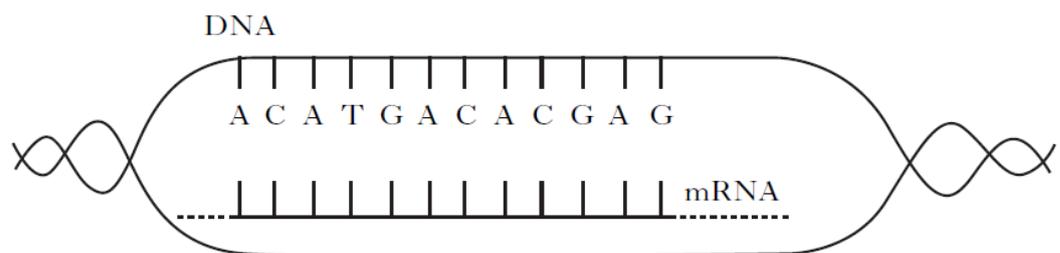
- A. Nonsense
- B. Missense
- C. Frameshift
- D. Splice-site

44. Individuals with Cri-du-chat syndrome have shortened chromosome 5. No other chromosomes are affected.

Which type of mutation causes Cri-du-chat syndrome?

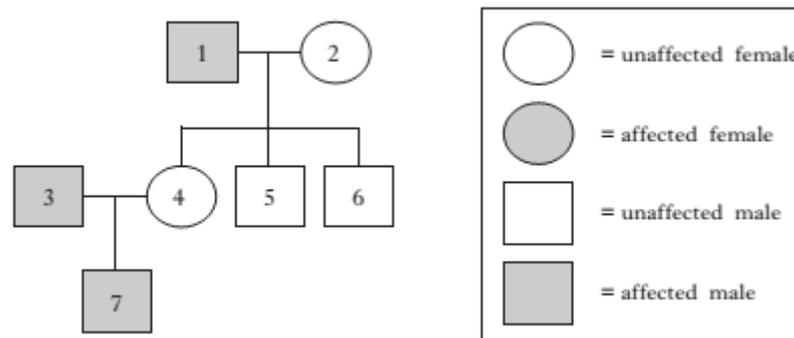
- A. Deletion
- B. Insertion
- C. Duplication
- D. Translocation

45. The diagram shows part of an mRNA molecule being formed on a strand of DNA.



- a. i) In which part of the cell is mRNA formed? (1)
- ii) Copy and complete the mRNA molecule by filling in the correct base sequence on the diagram. (1)
- iii) How many amino acids are coded for by this section of mRNA? (1)
- b. Some diseases are caused when cells in the body produce a harmful protein. Recent research has led to the development of antisense drugs to treat such diseases. These drugs carry a short strand of RNA nucleotides designed to attach to a small part of the mRNA molecule that codes for the harmful protein.
  - i. Suggest how these drugs may prevent the production of a harmful protein. (1)
  - ii. Antisense drugs can be used to treat autoimmune diseases. Describes what is meant by an autoimmune disease. (1)

46. The diagram below shows the inheritance of a sex-linked condition in a family.



- a. The condition is caused by a recessive sex-linked allele represented by the letter d.
  - i. State the genotypes of individuals 3 and 4. (1)
  - ii. Explain why individual I could not pass the condition to his sons. (1)
  - iii. Individual 6 has a son with a woman who is a carrier of the condition. Calculate the percentage change of their son having this condition. (1)
- b. The condition is caused by a mutation in which an extra nucleotide is inserted into the gene that codes for an enzyme. Explain the likely effect of this mutation on the structure of the enzyme. (2)
- c. The condition occurs with a frequency of 1 in 350 males. Assuming an equal proportion of males and females, calculate how many makes are likely to have the condition in a town with a population of 175000. (1)

### Human Genomics

47. During the polymerase Chain reaction (PCR) samples of DNA are repeatedly heated and cooled.

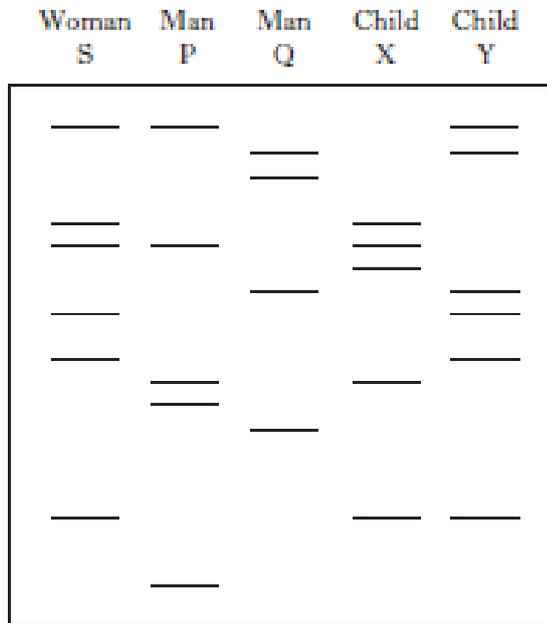
Why are the samples cooled?

- A. To denature the DNA polymerase
- B. To slow the reaction down
- C. To allow primers to bind to target sequences
- D. To separate the DNA strands

48. What is the function of a DNA probe?

- A. To replicate a particular region of DNA
- B. To join fragments of DNA together
- C. To remove non-coding sections of DNA
- D. To detect the presence of specific DNA sequences

49. The diagram below shows the results of a paternity test. It compares DNA samples from five individuals. Woman S is the mother of child X and child Y. Men P and Q are possible fathers of these children.



Which of the following conclusions can be drawn from these results?

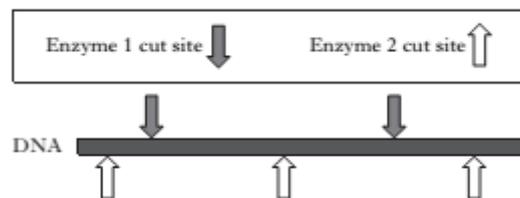
- A. Man P could be the father of child X
  - B. Man P could be the father of child Y
  - C. Man Q could be the father of child X
  - D. Man Q could be the father of child Y
50. Bioinformatics is the study of information from
- A. DNA transcription
  - B. DNA sequencing
  - C. Nerve impulses in the brain
  - D. The receptors of nerve endings

51. Some of the following are steps used in the amplification of DNA by PCR.
1. Decrease temperature to separate the DNA strands
  2. Increase temperature to separate the DNA strands
  3. Increase temperature for primers to bind to target sequences
  4. Decrease temperature for primers to bind to target sequence
  5. Increase temperature for DNA polymerase to replicate the DNA
  6. Increase temperature for DNA ligase to replicate the DNA

Which line in the table below identifies the correct order of steps involved in a PCR cycle?

	First stage	Second stage	Third stage
A	3	1	6
B	3	1	5
C	2	4	5
D	2	4	6

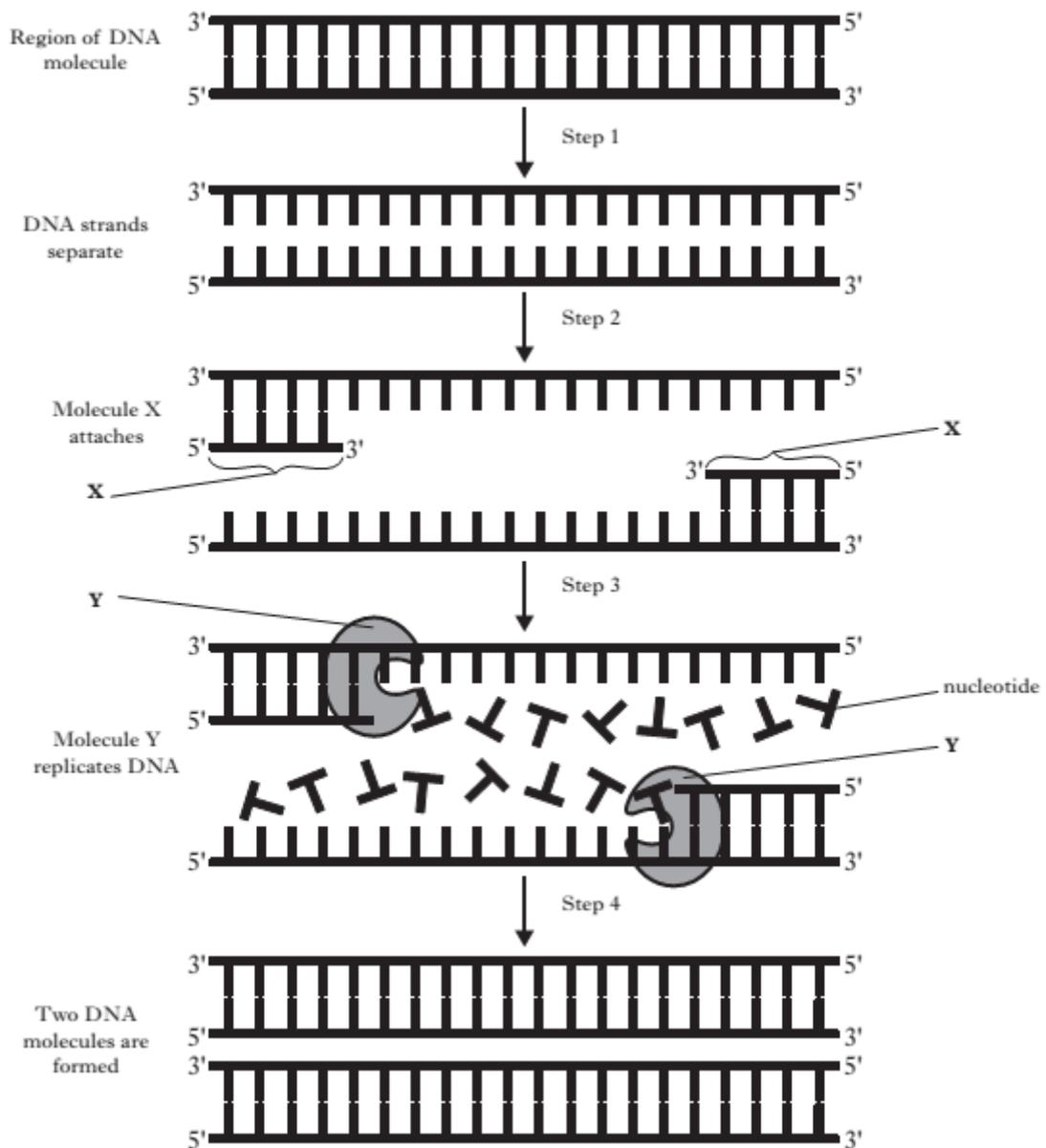
52. DNA profiling may be used in criminal investigations. During this procedure DNA is cut into fragments by two different enzymes. Each enzyme cuts DNA at a specific point.



Which line in the table below gives the correct number of DNA fragments produced from this DNA strand?

	<i>Number of fragments produced using</i>		
	<i>Enzyme 1 only</i>	<i>Enzyme 2 only</i>	<i>Enzymes 1 and 2</i>
A	2	3	5
B	2	3	6
C	3	4	7
D	3	4	6

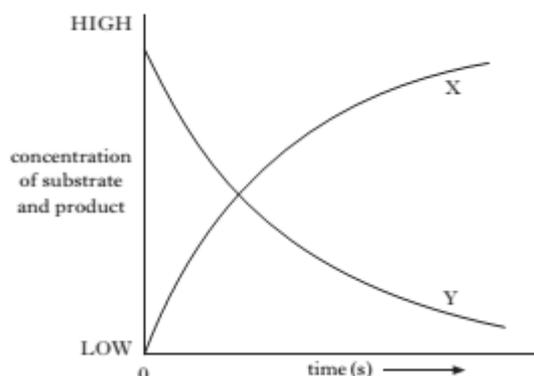
53. The diagram below represents steps in one cycle of the polymerase chain reaction (PCR).



- State the structural difference between the 3' and 5' end of a DNA strand. (1)
  - Describe how the DNA is treated during step 1. (1)
  - Name molecule X. (1)
  - Name molecule Y and describe its role in the replication of DNA (2)
- State the term which describes the production of multiple copies of DNA using PCR. (1)
- PCR is used to produce copies of DNA for DNA profiling. State the feature of DNA which allows profiling to identify different individuals. (1)

## Metabolic Pathways

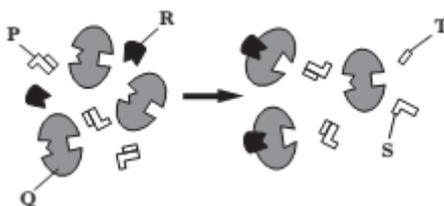
54. The graph below shows the changes to the concentrations of substrate and product during an enzyme-controlled reaction.



Which line in the table below correctly identifies the substrate, product and the change in the rate of the reaction during the process?

	<i>Substrate</i>	<i>Product</i>	<i>Rate of reaction</i>
A	X	Y	Increasing
B	X	Y	Decreasing
C	Y	X	Increasing
D	Y	X	Decreasing

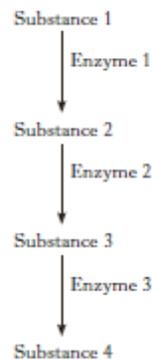
55. The diagram below shows an enzyme-catalysed reaction taking place in the presence of an inhibitor.



Which line in the table below correctly identifies the molecules in the reaction?

	Inhibitor	Substrate	Product
A	P	R	S
B	Q	P	S
C	R	P	T
D	R	Q	T

56. The diagram below shows a metabolic pathway that is controlled by end products inhibition.



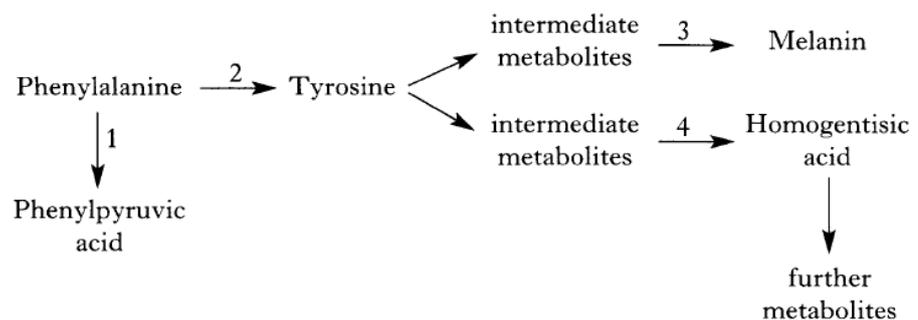
For substance 4 to bring about end product inhibition, with which of the following interact?

- A. Enzyme 1
- B. Enzyme 3
- C. Substance 1
- D. Substance 3

57. Which of the following describes metabolism correctly?

- A. The breakdown of chemicals to release energy
- B. The synthesis of large molecules
- C. The chemical reactions of organisms
- D. The breakdown of food molecules

58. The diagram below shows part of the metabolic pathway. Each stage is controlled by an enzyme.



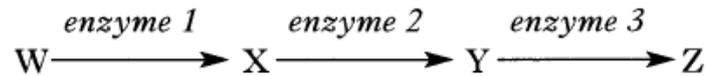
Phenylketonuria (PKU) is caused by a mutation of the gene required to make enzyme.

- A. 1
- B. 2
- C. 3
- D. 4

59. Which of the following correctly describes metabolism?

- A. The breakdown of chemicals to release energy
- B. The rate at which an organism produces heat energy
- C. The chemical reactions of organisms
- D. The breakdown of food molecules

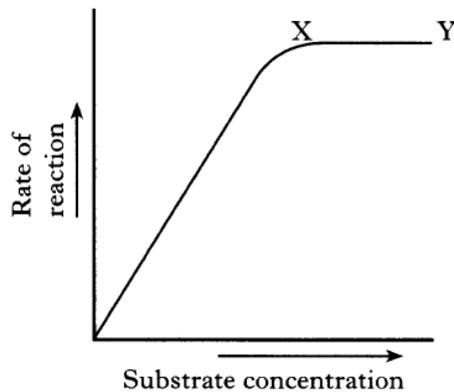
60. A series of enzyme-controlled reaction is shown below.



If an inhibitor which affects enzyme 2 is introduced to the system, which of the following will happen?

- A. X will accumulate
- B. Y will accumulate
- C. X and Y will accumulate
- D. Y and Z will accumulate

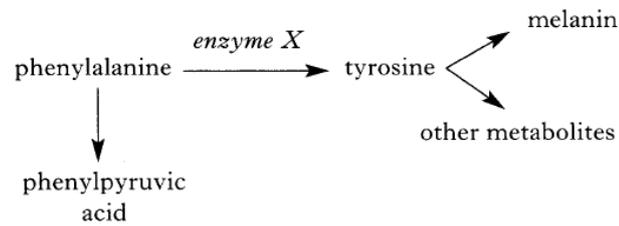
61. The graph shows the effect of substrate concentration on the rate of an enzyme-controlled reaction.



The graph levels out between points X and Y because the

- A. Enzyme is denatured
- B. Active sites are saturated with substrate
- C. Enzyme is inhibited
- D. Enzyme is activated.

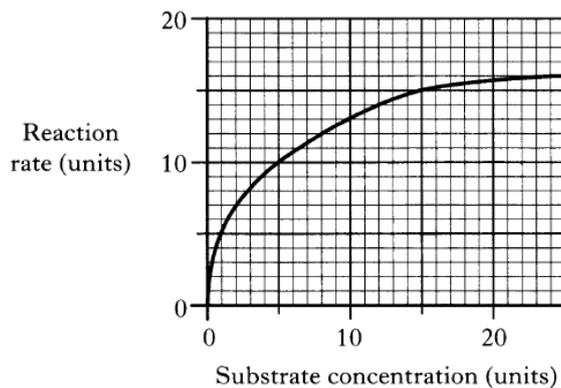
62. Phenylketonuria (PKU) is a metabolic disorder which can be lethal in childhood. It is caused by an inability to make enzyme X, shown in the metabolic pathway below.



Which substance would have to be removed from the diet for someone who has this disorder?

- A. Phenylalanine
  - B. Enzyme X
  - C. Tyrosine
  - D. Melanin
63. Non-competitive inhibitors affect enzyme action by
- A. Acting as a co-enzyme for enzyme action
  - B. Altering the shape of the substrate molecule
  - C. Competing for the active site of the enzyme
  - D. Altering the shape of the active site of the enzyme.

64. The graph shows the effect of substrate concentration on the rate of an enzyme -catalysed reaction.



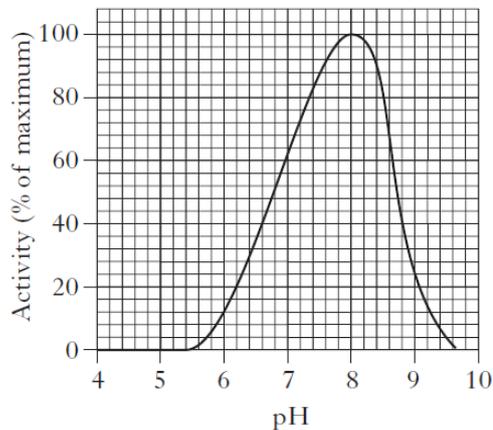
At what substrate concentration is the reaction rate equal to 75% of the maximum rate?

- A. 6 units
- B. 8 units
- C. 12 units
- D. 18 units

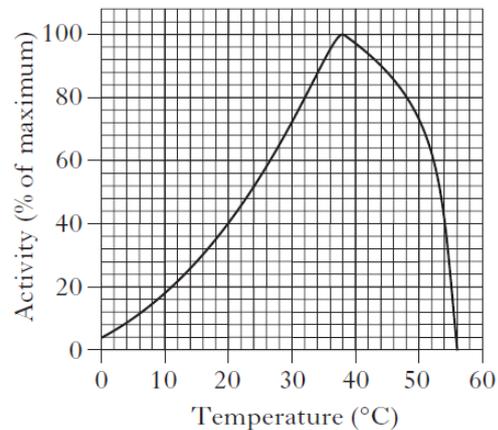
65. Trypsin is an enzyme which catalyses the breakdown of proteins in the small intestine.

The graphs below show how pH and temperatures affect the activity of trypsin.

**Graph 1**—effect of pH on trypsin activity



**Graph 2**—effect of temperature on trypsin activity



- a.
  - i) State the optimum conditions for trypsin activity. (1)
  - ii) State the range of condition over which trypsin shows the least 40% of its maximum activity. (1)
  - iii) Explain the rapid decrease in activity shown in Graph 2. (2)
- b. The pancreas produces and releases trypsinogen which does not breakdown proteins. In the lumen of the small intestine, trypsinogen is converted to trypsin by the enzyme enterokinase.



- i) What term describes the effect of enterokinase in this reaction? (1)
- ii) Explain why trypsinogen is produced in the pancreas instead of trypsin. (1)

66. a) Photographic film consists of a clear sheet of plastic coated with chemicals that give it a dark appearance. The chemicals are stuck to the plastic by the protein gelatine.

An investigation was carried out using photographic film and the enzyme trypsin which digests protein.

A piece of photographic film was placed in a test tube containing a solution of trypsin, as shown in figure 1 below.

The time taken for the film to turn clear was measured.

The procedure was the repeated using different concentrations of trypsin solution.

The results of the investigation are shown in table 1 below.

Figure 1

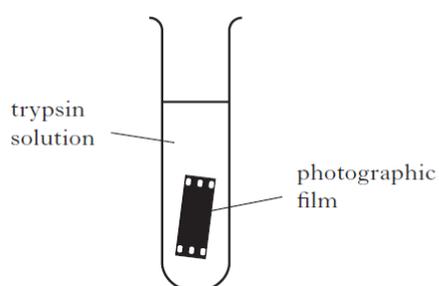


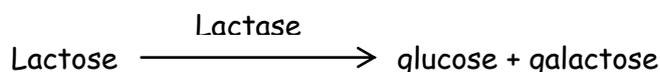
Table 1

<i>Trypsin concentration (%)</i>	<i>Time taken for film to clear (s)</i>
1	112
2	102
3	93
4	84
5	84
6	84

- i. Explain why the photographic film turns clear in the investigation. (1)
- ii. List two variables which would have to be kept constant throughout the investigation. (2)
- iii. How could the reliability of the results of this investigation be improved? (1)
- iv. Plot a line graph to illustrate the results of the investigation. (2)
- v. Explain why the time taken for the film to clear changed as trypsin concentration increased from 1% to 4%. (1)
- vi. Suggest why there was no change in the time taken to clear the film at trypsin concentrations above 4%. (1)

67. Lactose is the main sugar found in milk.

Lactose is broken down by lactase, an enzyme which is made by cells lining the small intestine. The glucose and galactose molecules produced are then absorbed into the bloodstream.



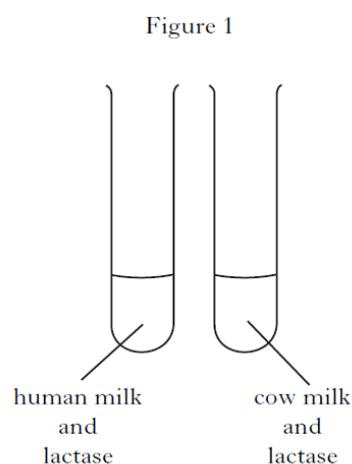
A student carried out an investigation to compare the lactose content of human milk and cow milk.

He set up a test tube containing human milk and lactase solution. Every 30 seconds samples were taken and the glucose concentration measured. Then he repeated the procedure with cow milk.

His experimental setup is shown in figure 1.

His results are shown in the table below.

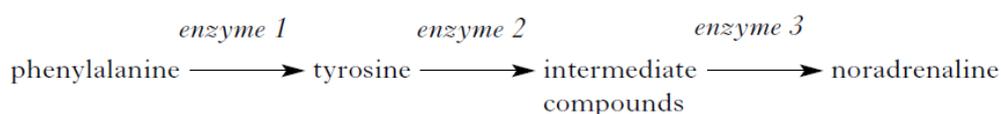
Time (min)	Concentration of glucose (%)	
	Human milk	Cow milk
0	0	0
0.5	0.28	0.28
1.0	0.54	0.46
1.5	0.80	0.54
2.0	1.04	0.58
2.5	1.10	0.58
3.0	1.10	0.58



- Lactose is a disaccharide sugar.  
Explain how the information above supports this statement. (1)
- One variable that must be kept constant in this investigation is pH.  
List two other variables which would have to be kept constant. (1)
- Construct a line graph to show all the data in the table. (3)
- What conclusion can be drawn from this investigation (1)
- Suggest a reason why the rate of glucose production is not constant throughout the investigation. (1)
- How could the student improve the reliability of his results? (1)

68. Many inherited conditions are caused by inborn errors of metabolism.
- What causes disorders that lead to inborn errors of metabolism? (1)
    - How do these inherited disorders affect metabolic pathways? (1)
  - Phenylketonuria (PKU) is an example of an inherited disorder.

One metabolic pathway affected by PKU is shown below.



- Describe how PKU affects the metabolic pathway shown above. (1)
  - With reference to the metabolic pathway shown, explain why PKU affects the nervous system. (1)
- c. What term describes the testing of newborn babies for inherited disorders such as PKU? (1)

69. Hydrogen peroxide is a toxic chemical which is produced during metabolism. Catalase is an enzyme which breaks down hydrogen peroxide as shown below.

Figure 1

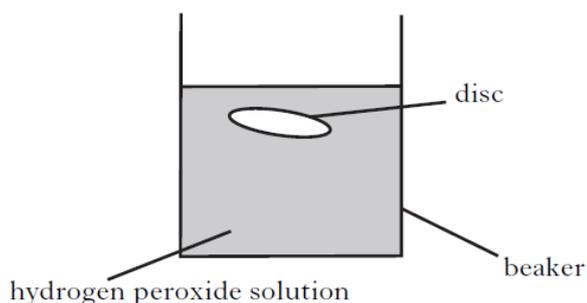


Table 1

<i>catalase concentration (%)</i>	<i>average time for ten discs to rise (s)</i>
0.125	9.8
0.25	6.9
0.5	5.0
1.0	3.8
2.0	3.8

Experiments were carried out to investigate how changing the concentration of catalase affects the rate of hydrogen peroxide breakdown.

Filter paper discs were soaked in catalase solutions of different concentrations. Each disc was then added to a beaker of hydrogen peroxide solution as shown in **Figure 1**.

The disc sank to the bottom of the beaker before rising back up to the surface. The time taken for each disc to rise to the surface was used to measure the reaction rates.

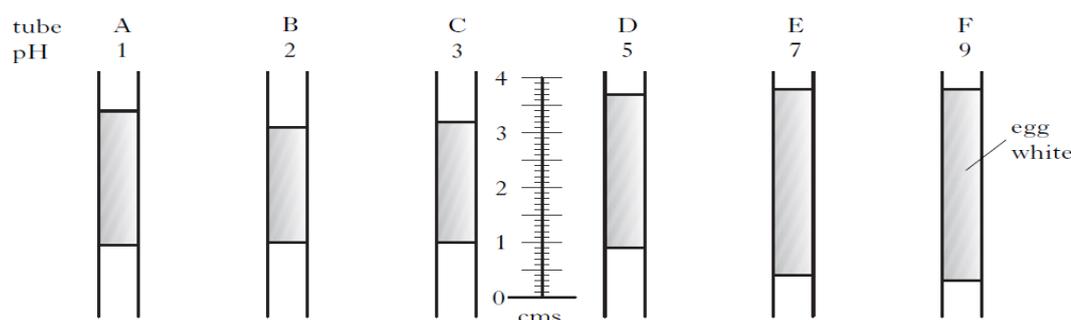
The results of the investigation are shown in **table 1**.

- Explain why the filter paper discs rose to the surface of the hydrogen peroxide solution. (1)
- Name three variables which should be controlled during this investigation. (2)
- What feature of this investigation makes the results more reliable? (1)

70. An experiment was carried out to investigate the effect of pH on the activity of the enzyme pepsin.

Six beakers were filled with pepsin solution and the pH adjusted in each beaker to give a range from pH 1 to pH 9. Six glass tubes were filled with egg albumen and boiled in water to set the egg white. The starting lengths of the egg white were measured and recorded in the table below.

The glass tubes were placed in the pepsin solution for a number of hours to allow digestion of the egg white. The lengths of egg white left in each tube at the end of the investigation are shown in the diagram below.

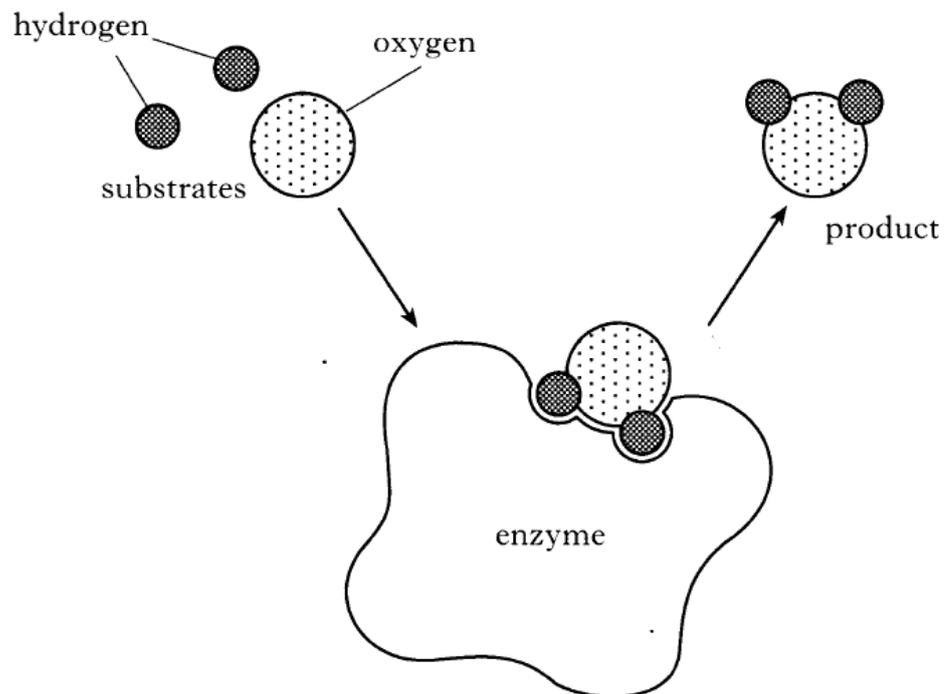


Tube	pH of pepsin solution	Length of egg white at start (mm)	Length of egg white at finish (mm)	Percentage decrease in length (%)
A	1	36	24	33
B	2	35	20	43
C	3	36		
D	5	34		
E	7	36	34	6
F	9	35	35	0

- a. i) Complete the table above by measuring and recording the final lengths of egg white in tubes C and D. (1)
- ii) Calculate the percentage decrease in length of egg white in tubes C and D and complete the table. (1)
- b. Draw a line graph to show the relationship between pH and percentage decrease in length of egg white. (2)
- c.
  - i. What conclusion can be drawn from the results of this experiment? (1)
  - ii. Predict the percentage decrease in length of egg white in pepsin solution of pH 12. (1)
  - iii. Why was it necessary to calculate a percentage decrease? (1)

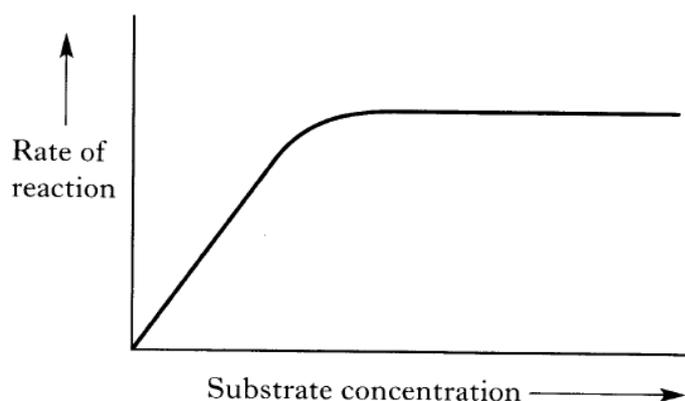
- iv. Describe a suitable control for tube A in this investigation. (1)
  - v. State three variables which would have to be kept constant throughout this investigation. (2)
  - vi. Describe one way in which the results could be made more reliable. (1)
- d. Pepsin is produced in an inactive form by cells lining the stomach. Why is it important that pepsin is inactive when it is produced? (1)

71. The diagram below represents a reaction catalysed by an enzyme in the cytochrome system.



- a. i) What name is given to the part of the enzyme where this reaction occurs? (1)
- ii) In which organelle would this reaction take place? (1)
- iii) Name the product of this reaction. (1)
- b. Cyanide is a poison which inhibits this enzyme. Suggest how cyanide is able to do this. (1)
- c. Why do many enzyme-catalysed reactions require the presence of vitamins or minerals? (1)

- d. The graph shows the effect of increasing substrate concentration on the rate of this reaction.



- i) Explain why the graph levels out at high substrate concentration. (1)
- ii) Assuming that the enzyme is operating at its optimum pH and temperature, suggest how the rate of reaction could be increased at high substrate concentrations. (1)

72. Discuss factors that affect enzyme activity. (10)

73. Give an account of enzymes under the following headings:

- i) factors affecting enzyme activity; (7)
- ii) activation of enzymes. (3)

## Cellular Respiration

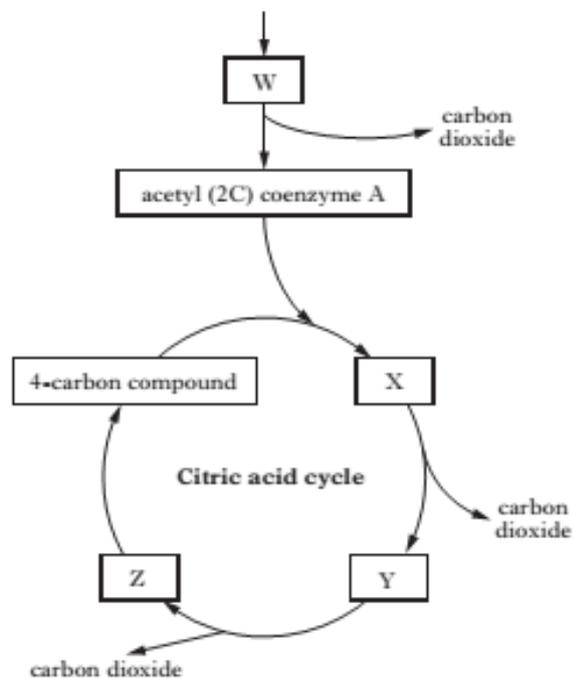
74. The following statements refer to respiration:

1. Carbon dioxide is released
2. Occurs during aerobic respiration
3. The end product is pyruvic acid
4. The end product is lactic acid

Which statements refer to glycolysis?

- A. 1 and 4
- B. 2 and 3
- C. 1 and 3
- D. 2 and 4

75. The diagram below illustrates some stages during respiration.



Which line in the table below correctly identifies the number of carbon atoms in compounds W, X, Y and Z?

	Number of carbon atoms			
	W	X	Y	Z
A	6	6	5	4
B	3	4	3	2
C	3	6	5	4
D	6	4	3	2

76. Which line in the table below describes correctly the function and location of dehydrogenase enzymes in respiration?

	Substance removed from substrate	Location
A	Electrons	Citric acid cycle
B	Electrons	Electron transport chain
C	Phosphate	Electron transport chain
D	phosphate	Citric acid cycle

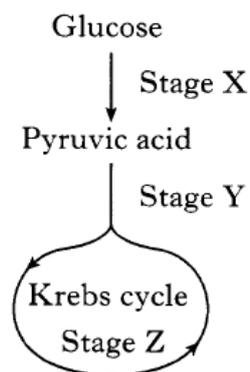
77. In respiration. The sequence of reactions resulting in the conversion of glucose to pyruvic acid is called

- A. The cytochrome system
- B. The TCA cycle
- C. The Krebs cycle
- D. Glycolysis

78. During which of the following chemical conversions is ATP produced?

- A. Amino acids  $\longrightarrow$  protein
- B. Glucose  $\longrightarrow$  pyruvic acid
- C. Haemoglobin  $\longrightarrow$  oxyhaemoglobin
- D. Nucleotides  $\longrightarrow$  mRNA

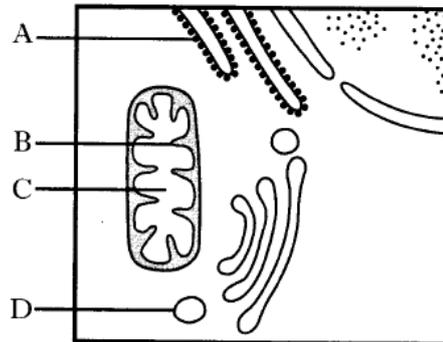
79. The following diagram represents stages in the complete breakdown of glucose in aerobic respiration.



At which stage, or stages, is carbon dioxide released?

- A. Stages X and Z
- B. Stages X and Y
- C. Stages Y and Z
- D. Stage Z only

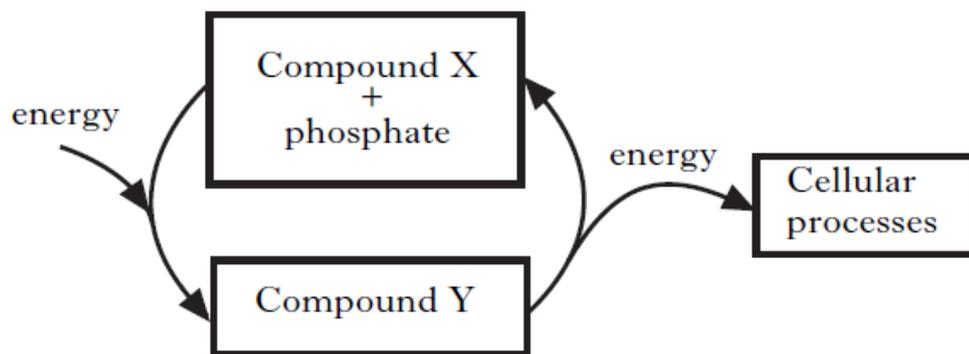
80. The diagram shows part of a liver cell with four parts labelled. In which part is most ATP produced?



81. The anaerobic breakdown of glucose splits from the aerobic pathway of respiration

- A. After the formation of pyruvic acid
- B. After the formation of acetyl CoA
- C. After the formation of citric acid
- D. At the start of glycolysis

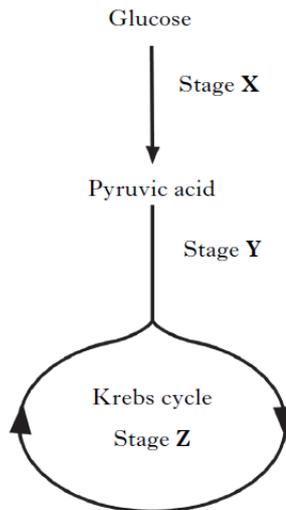
82. The diagram below shows energy transfer within a cell.



Which line in the table below identifies correctly compounds X and Y?

	X	Y
A	Glucose	ATP
B	Glucose	ADP
C	ADP	ATP
D	ATP	Glucose

83. The following chart shows stages in the complete breakdown of glucose in aerobic respiration.



At which stage or stages is hydrogen released to be picked up by hydrogen acceptors?

- A. Stages X, Y and Z
- B. Stages X and Y only
- C. Stages Y and Z only
- D. Stage Z only

84. The following statements relate to respiration and the mitochondrion.

1. Glycolysis takes place in the mitochondrion
2. The mitochondrion has two membranes
3. The rate of respiration is affected by temperature

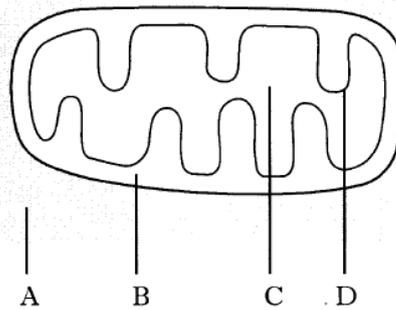
Which of the above statements are correct?

- A. 1 and 2
- B. 1 and 3
- C. 2 and 3
- D. All of them

85. In respiration, the products of the cytochrome system are

- A. Hydrogen and carbon dioxide
- B. Water and ATP
- C. Oxygen and ADP
- D. Pyruvic acid and water.

86. The diagram below shows a mitochondrion surrounded by cytoplasm.



Where does glycolysis take place?

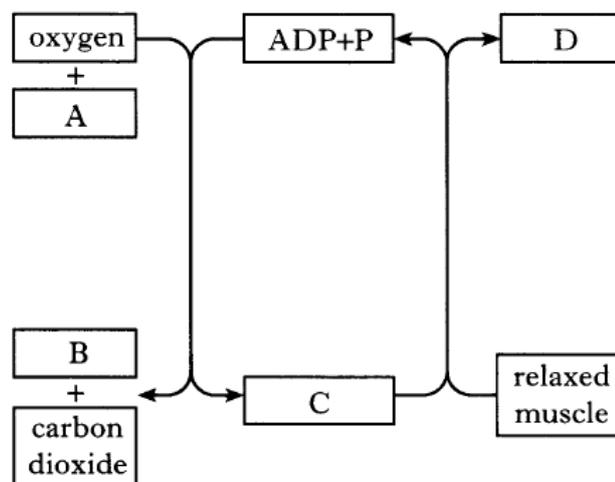
87. During anaerobic respiration in muscle fibres, what is the fate of pyruvic acid?

- A. It is converted to lactic acid
- B. It is broken down by the mitochondria
- C. It is broken down to carbon dioxide and water
- D. It is converted to citric acid

88. In respiration, the sequence of reactions resulting in the conversion of glucose to pyruvic acid is called

- A. the Krebs cycle
- B. the citric acid cycle
- C. glycolysis
- D. the cytochrome chain.

89. The diagram below represents stages in tissue respiration.

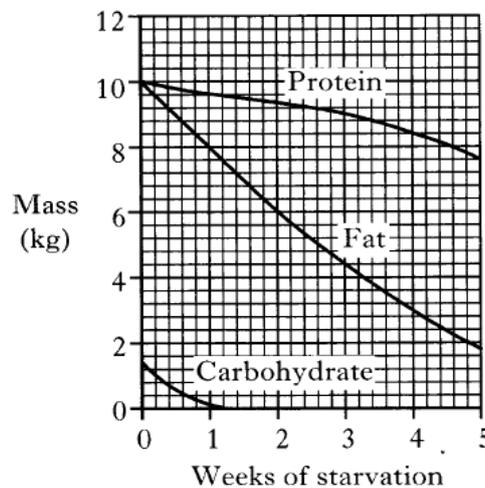


Which box represents ATP?

90. Which line in the table has pairs of statements which are true with regard to aerobic respiration and anaerobic respiration in human muscle tissue?

	Aerobic respiration	Anaerobic respiration
A	There is a net gain of ATP	Carbon Dioxide is not produced
B	There is a net gain of ATP	Oxygen is used up
C	Carbon dioxide is evolved	There is a net loss of ATP
D	Lactic acid is formed	Ethanol is formed

91. The graph below shows changes which occur in the masses of protein, fat and carbohydrate in a boy's body during five weeks of starvation.



The boy's weight is 60kg. Predict his weight after two weeks without food.

- A. 43kg
- B. 50kg
- C. 54kg
- D. 57kg

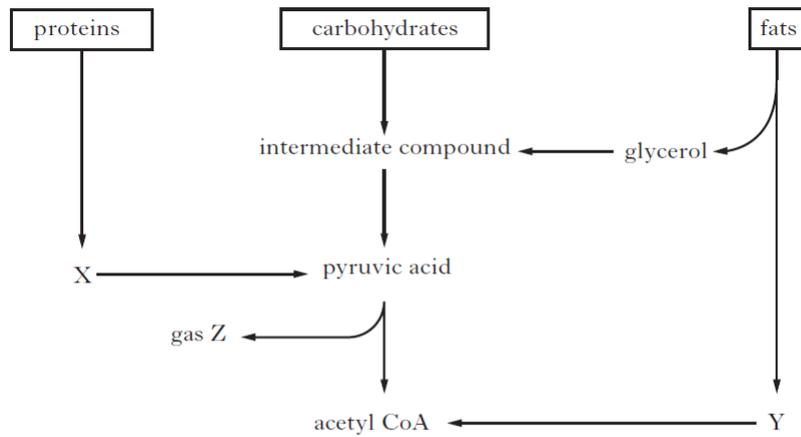
92. Which of the following must be present for glycolysis to occur?

- A. Glucose and oxygen
- B. ATP and oxygen
- C. Glucose and ATP
- D. ATP and pyruvic acid

93. Glycolysis takes place in the

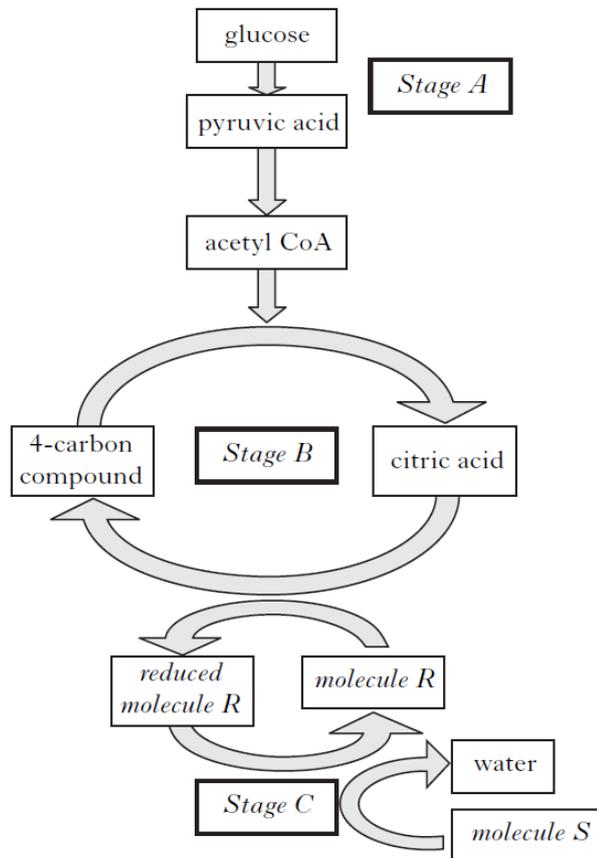
- A. Nucleus
- B. Cristae of mitochondria
- C. Matrix of mitochondria
- D. Cytoplasm

94. The diagram below shows the metabolism of three energy sources in a cell.



- Name X, Y and Z. (2)
- What term describes the breakdown of carbohydrate into pyruvic acid during respiration? (1)
- Describe what happens to acetyl CoA after it enters the Krebs Cycle. (1)
- Under what circumstances would the body gain most of its energy from proteins? (1)
- Carbohydrate is stored in the body as polysaccharide. Name this polysaccharide and state where it is stored. (1)

95. The diagram below shows some of the reaction which occur during aerobic respiration.



- a. Copy and complete the table by naming stages A, B and C and indicating their exact location within the cell. (3)

Stage	Name	Location
A		
B		
C		

- b. A glucose molecule contains 6 carbon atoms.  
 How many carbon atoms are found in Pyruvic acid and Citric acid? (1)
- c. Copy and complete the following sentences by naming molecules R and S describing their function with respect to stage C.

R is \_\_\_\_\_ and its function is

\_\_\_\_\_

S is \_\_\_\_\_ and its function is

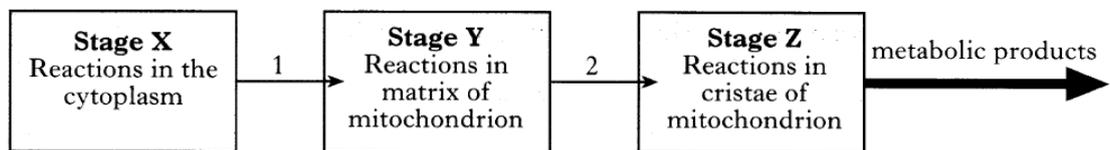
\_\_\_\_\_ (2)

d. Under normal circumstances carbohydrate is the main respiratory substrate.

In each of the following extreme situations, state the alternative respiratory substrate and explain why the body has to use it. (2)

Situation	Respiratory substrate	Explanation
Prolonged starvation		
Towards the end of a marathon race		

96. The diagram below shows three stages that occur during aerobic respiration.

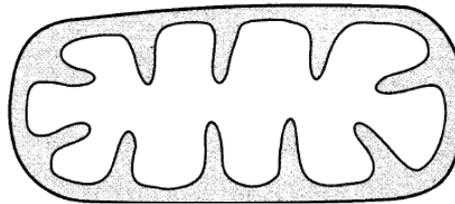


- a. Name each stage. (2)
- b. i) Arrows 1 and 2 represent the transfer of molecules from one stage to another. Complete the table to identify these molecules. (2)

Arrow	Name of molecules
1	
2	

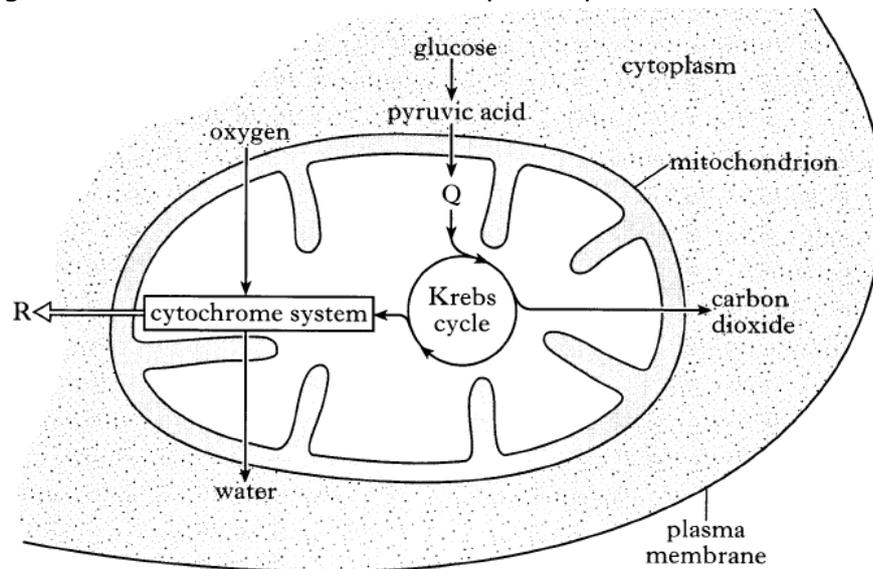
ii) Name the two metabolic products of stage Z. (1)

c. The diagram below shows a mitochondrion from a skin cell.



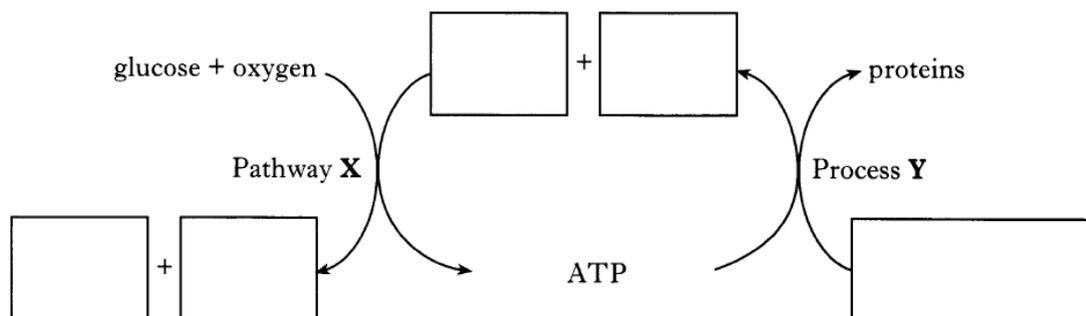
Describe how the structure of a mitochondrion from an active muscle cell would differ from the one shown. Give a reason for your answer. (2)

97. The diagram below summaries a metabolic pathway within a cell.



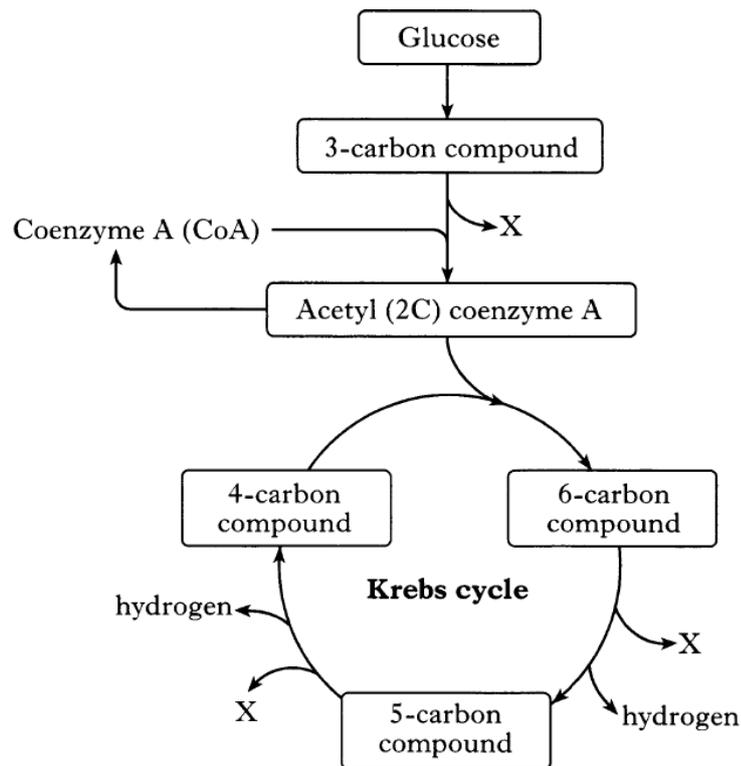
- Name the process which results in the formation of pyruvic acid. (1)
- Name substance Q. (1)
- How many carbon atoms are removed in one turn of the Krebs cycle? (1)
- What is the role of NAD in this process? (1)
- Why does the cytochrome system stop when oxygen is absent? (1)
- Substance R is the main product of the cytochrome system.  
Where in this metabolic pathway is substance R required? (1)

98. The diagram shows the role of ATP in cell metabolism.



- Complete the diagram by entering the names of the appropriate substances. (3)
- Name one stage of pathway X and state where it occurs in the cell, (1)
  - Name the organelle where process Y occurs. (1)
- Describe two ways in which the diagram would be different under anaerobic conditions. (2)
- Name a respiratory substrate other than glucose. (1)

99. The diagram below represents two stages in the chemistry of respiration in a cell which is respiring aerobically.



- Name the 3-carbon compound and the 6-carbon compound. (2)
- Draw a line across the diagram to indicate where this series of reactions would stop if oxygen were not available. (1)
- State the precise location of the Krebs cycle within the cell. (1)
- Copy and complete the table below to name the product X and to describe what happens to each of the products. (2)

<i>Product</i>	<i>Fate of product</i>
X-	
Hydrogen	

100. Discuss the production and use of ATP in the body. (8)

## Energy Systems in Muscle Cells

101. A piece of muscle was cut into three strips X, Y and Z and treated as described in the table.

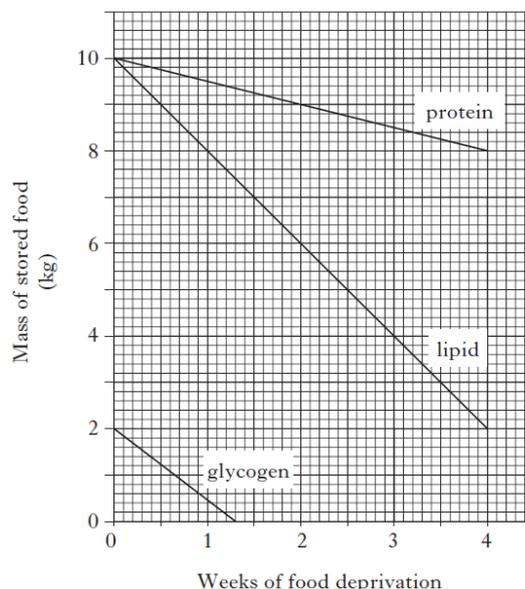
Their final lengths were then measured.

Muscle strip	Solution added to muscle	Muscle lengths (mm)	
		Start	After 10 minutes
X	1 % glucose	50	50
Y	1 % ATP	50	45
Z	1% ATP boiled and cooled	50	46

From the data it may be deduced that

- A. ATP is not an enzyme
- B. Muscles contain many mitochondria
- C. Muscles synthesise ATP in the absence of glucose.
- D. Muscles do not use glucose as a source of energy.

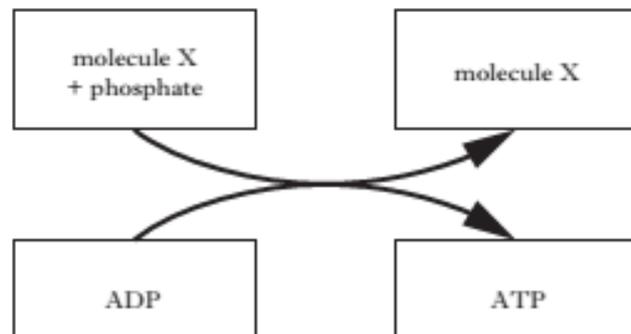
102. The graph below shows the changes which occur in a body's food stores during four weeks of food deprivation.



Which of the following conclusions can be drawn from the graph?

- A. The glycogen food store decreases at the fastest rate during week one.
- B. Between weeks three and four the body gains most energy from protein
- C. Each food store decreases at a constant rate during week one.
- D. Between weeks one and four the body only gains energy from lipid and protein.

103. The diagram below summaries the production of ATP in a muscle cell during exercise.



What is molecule X?

- A. Glucose
- B. Pyruvate
- C. Creatine
- D. NAD

104. Which line in the table below identifies correctly the properties of slow twitch muscle fibres?

	<i>Relative number of mitochondria</i>	<i>Concentration of myoglobin</i>	<i>Major storage fuel</i>
A	Many	Low	Fats
B	Many	High	Fats
C	Few	Low	Glycogen
D	few	high	Glycogen

105. Which of the following equations describes correctly the role of creative phosphate?

- A.  $ADP + phosphate + creatine \longrightarrow creatine\ phosphate + ATP$
- B.  $Creatine\ phosphate + ADP \longrightarrow ATP + creatine$
- C.  $Creatine\ phosphate + ATP \longrightarrow ADP + phosphate + creatine$
- D.  $ATP + phosphate \longrightarrow creatine\ phosphate + ADP$

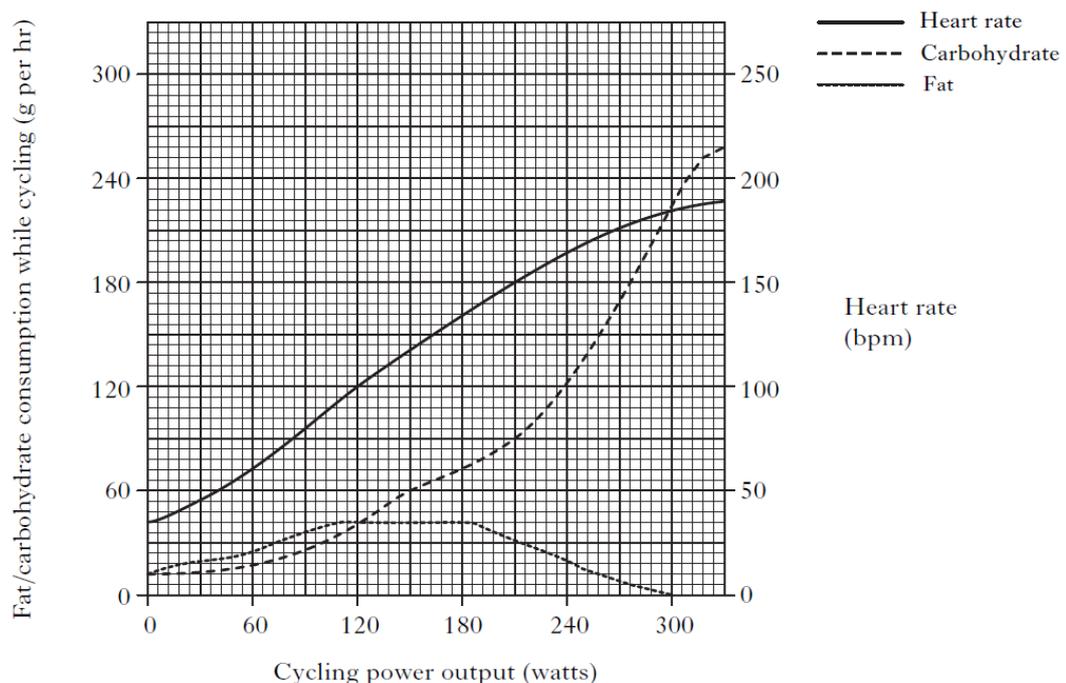
106. Which line in the following table describes correctly fast-twitch muscle fibres?

	Main storage fuel	Number of mitochondria compared to slow-twitch muscle fibres
A	Fat	Fewer
B	Fat	Higher
C	Glycogen	Fewer
D	Glycogen	Higher

107. An investigation was carried out to find out how a cyclist's metabolism changed while he pedalled at increasing speed.

The cyclist's heart rate, fat and carbohydrate consumption were measured at different power outputs.

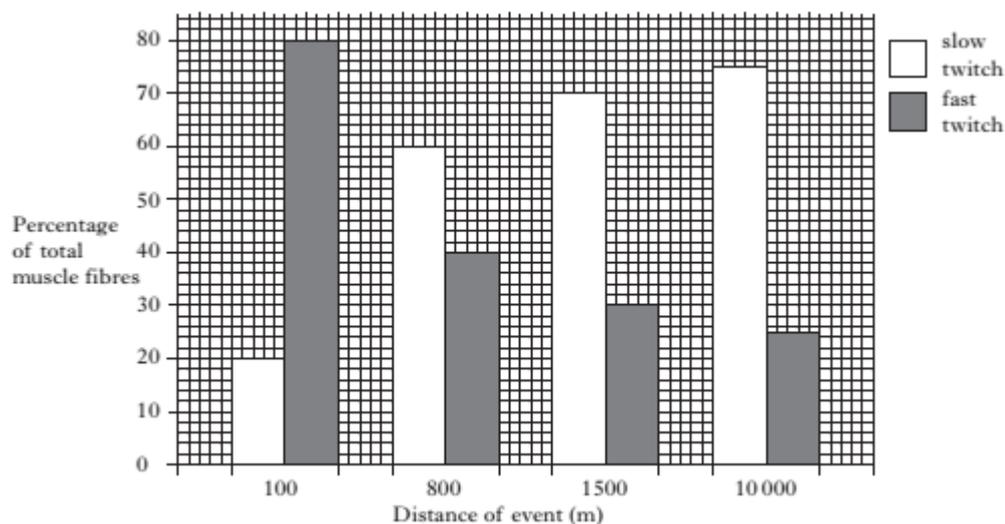
The graph below shows the results of the investigation.



- What is the heart rate of the cyclist when his power output is 90 watts? (1)
- What evidence is there from the graph that the cyclist is very fit? (1)
- Compare the consumption of fat and carbohydrate as cycling power increases. Quote data from the graph in your answer. (3)
- Cyclists often use heart-rate monitors in training. A cyclist wishes to maintain his fat consumption at its maximum and, at the same time, limit his carbohydrate consumption. At what heart rate should he cycle? (1)
  - Suggest why it is good practice in a long distance cycling race to maximise fat consumption and minimise carbohydrate consumption. (1)

- e. The cyclist raced for 4 hours at a power output of 210 watts. During that time he consumed 100g of carbohydrate in a liquid drink. Assuming he started with a carbohydrate store of 300g, how much carbohydrate would he be left with at the end of the race? (1)
- f. i) Glycogen is a major source of carbohydrate. Where is glycogen stored in the body? (1)
- ii) Name a hormone which promotes the conversion of glycogen to glucose. (1)
- iii) What substance is used as a source of energy after glycogen and fat stores have been used up? (1)

108. The graph below compares the percentage of slow twitch and fast twitch muscle fibres found in Commonwealth Games athletes competing in track events of different distances.



- a. i) Express, as a simple whole number ratio, the percentage of slow twitch to fast twitch muscle fibres found in the 10000 metre runner. (1)
- ii) Explain why the 10000 metre runner requires a high percentage of slow twitch muscle fibres. (1)
- b. Describe the trends shown in the graph. (1)
- c. Describe two structural differences between slow twitch and fast twitch muscle fibres. (2)