

1)

Molecules are transported into and out of cells by several mechanisms.

(a) Read through the following passage that describes some of these mechanisms, then write on the dotted lines the most appropriate word or words to complete the passage.

(4)

Some molecules move across a cell surface membrane by passing down a concentration gradient, through the phospholipid bilayer. The movement of some polar molecules across the membrane involves carrier and channel

..... molecules. When this movement occurs down a concentration gradient, the process is called ..... and when it occurs against a concentration gradient the process is called .....

Energy in the form of ..... is used in the movement of molecules against a concentration gradient.

- (b) A student wanted to sweeten some strawberries, so she sprinkled some sugar on top of them, one hour before eating them. The student noticed that the sugar that she had sprinkled on them was no longer visible and that there was some juice at the bottom of the bowl.



Appearance on adding sugar



Appearance one hour after adding sugar

The student thought that the juice was the sugar dissolved in water and that the water had come from the fruit.

In order to test this hypothesis, she weighed some fresh strawberries and sprinkled them with sugar. One hour later she rinsed off the juice and reweighed the strawberries. The mass of the strawberries before adding the sugar was 77 g. The mass after rinsing off the juice was 70 g.

- (i) Calculate the percentage decrease in the mass of the strawberries.

Show your working.

(2)

- (ii) Suggest **one** possible source of error in the student's procedure that could make this value for the percentage decrease in the mass of the strawberries inaccurate.

Explain how this source of error would affect the value for the percentage decrease in the mass of the strawberries.

(3)

- (iii) Using your knowledge of cell transport mechanisms and the properties of water, explain how the juice is formed from the water that came from the fruit.

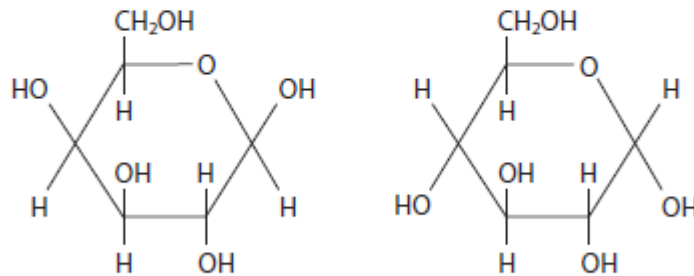
(3)

2)

Galactosaemia is a genetic disorder that affects an individual's ability to metabolise the monosaccharide galactose.

Dairy products contain the disaccharide lactose, which is broken down into galactose and glucose during digestion. If the galactose is not broken down further this may result in damage to the brain, kidneys or liver.

(a) The diagram below shows the structure of a galactose molecule and a glucose molecule.



(i) In the space below, draw a diagram to show the products formed when these two molecules join together to form lactose.

(3)

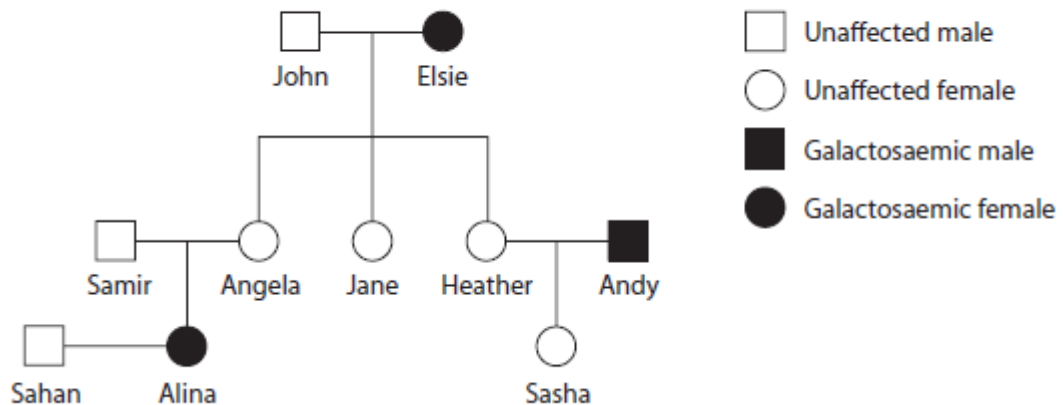
(ii) Name the chemical reaction that joins the galactose and glucose molecules together.

(1)

(iii) Name the bond that joins the galactose and glucose molecules together.

(1)

(b) The pedigree diagram below shows the inheritance of galactosaemia in a family.



The normal allele is represented by G and the defective recessive allele by g.

Place a cross  in the box next to the correct letter that completes each of the following statements.

(i) An allele is a

(1)

- A form of a gene
- B length of DNA
- C part of a gene
- D protein

(ii) If John is heterozygous for galactosaemia, Jane's genotype must be

(1)

- A GG
- B Gg
- C gg
- D impossible to tell

(iii) Samir's genotype must be

(1)

- A GG
- B Gg
- C gg
- D impossible to tell

(c) (i) Use a genetic diagram to calculate the probability that Sahan and Alina's first child will be heterozygous (a carrier) if Sahan is heterozygous.

(4)

Answer .....

(ii) What is the probability that their second child would also be a carrier?

(1)

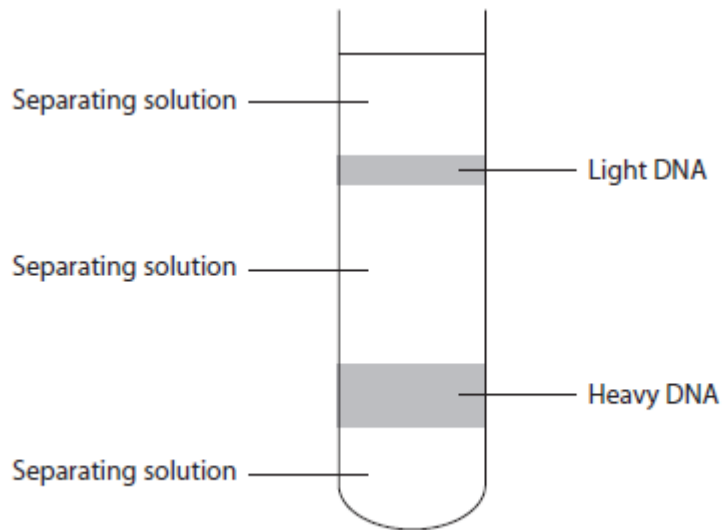
3)

In the late 1950s, Meselson and Stahl performed some important experiments. These experiments provided evidence to support the idea that new DNA was synthesised by semi-conservative replication.

(a) Name an enzyme involved in DNA replication.

(1)

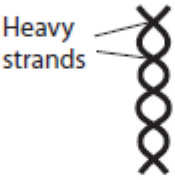

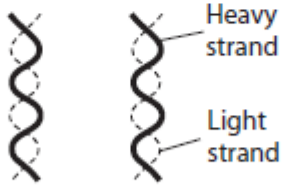

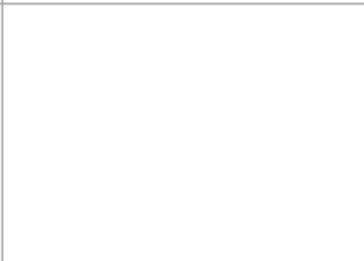

(b) Meselson and Stahl's experiments involved growing bacteria in culture media containing either heavy nitrogen ( $^{15}\text{N}$ ) or light nitrogen ( $^{14}\text{N}$ ). The DNA was then extracted from the bacteria. The DNA was analysed as shown in the diagram below.



The table below summarises the three stages of Meselson and Stahl's experiment and their results.

Complete the table by drawing, in the appropriate boxes, diagrams of the DNA molecules and mark the position and size of the DNA bands in the tubes.

(6)

Experimental stage	Diagram to show the strands in the DNA molecules of the bacteria	Position and size of DNA bands in the tube of separating solution
<p><b>Stage 1</b> Bacteria grown for several generations in culture medium containing heavy nitrogen</p>		
<p><b>Stage 2</b> The bacteria from the end of stage 1 were grown for another generation in culture medium containing light nitrogen</p>		
<p><b>Stage 3</b> The bacteria from the end of stage 2 were grown for one more generation in culture medium containing light nitrogen</p>		

4)

The sequence of amino acids in a polypeptide chain is determined by the sequence of bases in DNA. This sequence of bases is used as a template to synthesise messenger RNA (mRNA).

(a) Describe the structure of an amino acid.

(2)

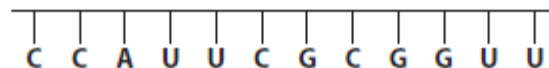
(b) Describe how mRNA is synthesised.

(4)

(c) The table below shows the amino acids coded for by the codons on mRNA.

Three-letter codons of mRNA and the amino acids specified by the codons							
AAU } AAC }	Asparagine	CAU } CAC }	Histidine	GAU } GAC }	Asparatic acid	UAU } UAC }	Tyrosine
AAA } AAG }	Lysine	CAA } CAG }	Glutamine	GAA } GAG }	Glutamate	UAA } UAG }	Stop
ACU } ACC } ACA } ACG }	Threonine	CCU } CCC } CCA } CCG }	Proline	GCU } GCC } GCA } GCG }	Alanine	UCU } UCC } UCA } UCG }	Serine
AGU } AGC }	Serine	CGU } CGC } CGA } CGG }	Arginine	GGU } GGC } GGA } GGG }	Glycine	UGU } UGC }	Cysteine
AGA } AGG }	Arginine					UGA } UGG }	Stop Tryptophan
AUU } AUC } AUA }	Isoleucine	CUU } CUC } CUA } CUG }	Leucine	GUU } GUC } GUA } GUG }	Valine	UUU } UUC }	Phenylalanine
AUG	Methionine					UUA } UUG }	Leucine

The diagram below shows part of a messenger RNA molecule.



(i) Place a cross  in the box next to the complementary sequence of bases found on the strand of the DNA molecule, from which part of this mRNA molecule was synthesised.

- A G G T A A G C G C C T T
- B G G U A A C G C G G A A
- C A A C G G A U A U U G G
- D A A C G G A T A T T G G

(1)

(ii) Place a cross ☒ in the box next to the sequence of amino acids found in the polypeptide chain that is coded for by this part of the **mRNA** molecule.

- A proline lysine alanine valine (1)
- B proline phenylalanine alanine valine
- C glycine lysine arginine glutamine
- D proline lysine alanine glutamine

(iii) Place a cross ☒ in the box next to the final codon on this **mRNA** molecule if GUU is the last codon for an amino acid.

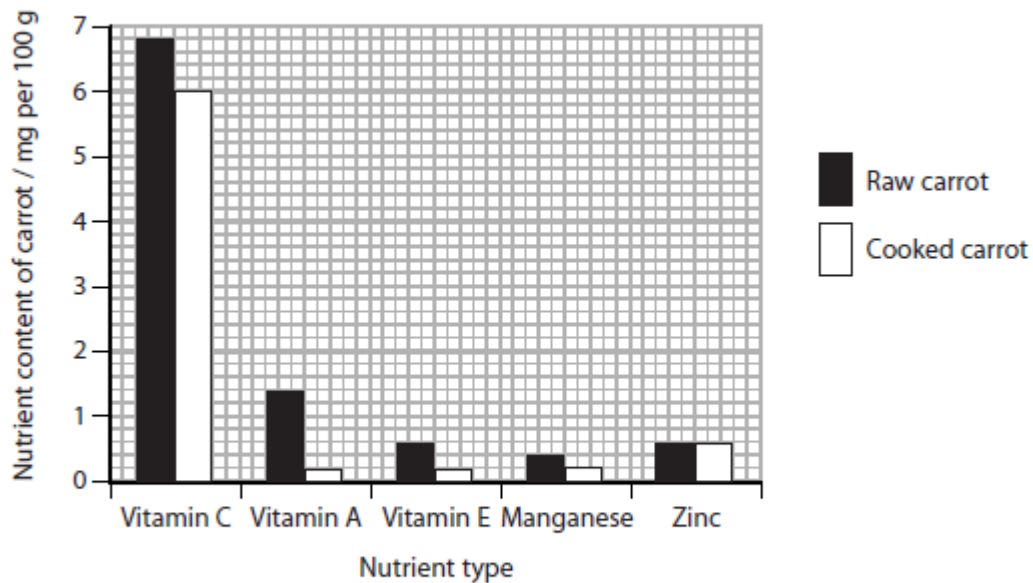
(1)

- A AGU
- B ACU
- C UCA
- D UGA

5)

When vegetables are cooked in boiling water, they may lose some of their nutrients.

The graph below shows the effect of cooking on the content of three vitamins and two minerals found in carrots.



(a) Using the information in the graph, compare the effects of cooking on the content of vitamins and minerals found in carrots.

(3)



\*(b) It has been suggested that cooking food in a microwave oven does not reduce the nutrient content of foods by as much as cooking in boiling water.

A student wanted to test this idea on the vitamin C content of carrots.

Describe an investigation that the student could carry out to compare these two methods of cooking on the vitamin C content of carrots.

(5)

6)

Read through the following passage on the structure of DNA, then write on the dotted lines the most appropriate word or words to complete the passage.

(8)

A DNA molecule consists of two strands of mononucleotides. Each of these strands

is twisted around the other, forming a .....

Each mononucleotide consists of a pentose sugar called .....,

a base and a ..... In each strand, the mononucleotides are

held together by ..... bonds.

The two strands are held together by complementary base pairing. Adenine bonds

with ..... and cytosine bonds with .....

The name of the bond that forms between these bases is a

..... bond. A DNA molecule that is composed of 34% adenine

will be composed of ..... % cytosine.

7)

The size and solubility of molecules has an effect on their ability to be taken up by cells.

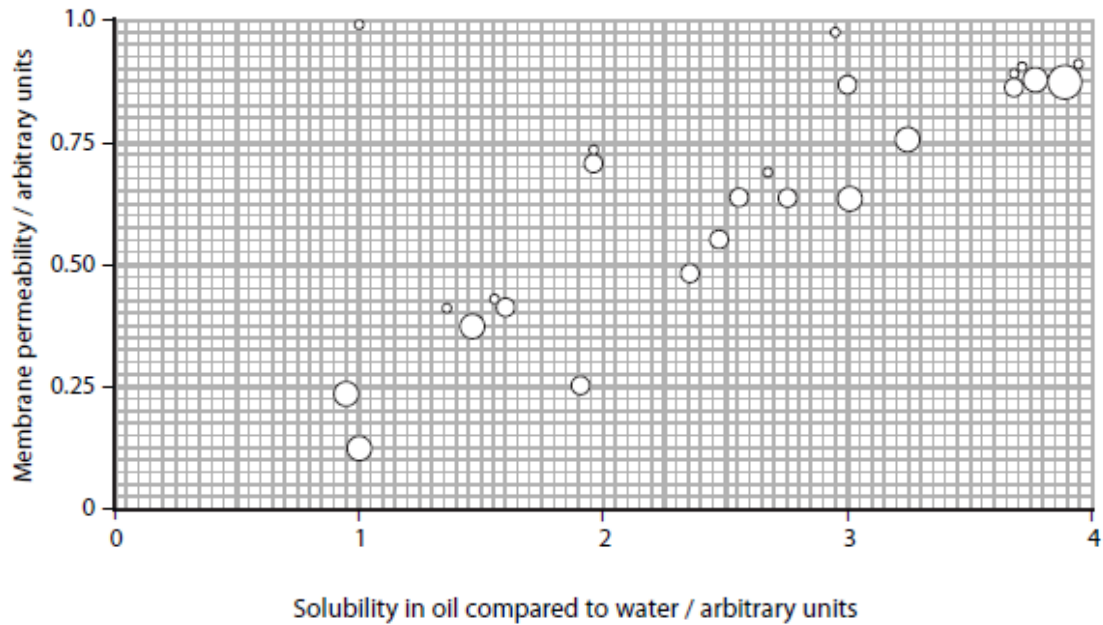
\*(a) Describe an experiment you have carried out to investigate the permeability of cell membranes.

(5)

(b) An investigation was carried out into the permeability of a cell membrane to a number of different non-polar, organic molecules. The molecules differed in their size and in their solubility in oil compared with their solubility in water. The higher the solubility, the more soluble the molecule is in oil compared with water.

The graph below shows the results of this investigation.

The size of the circle drawn on the graph indicates the size of the molecule; the larger the circle, the larger the molecule.



- (i) Describe what relationship, if any, there is between the permeability of this cell membrane and the **size** of the molecules. (1)
- ..... (ii) Describe what relationship, if any, there is between the permeability of this cell membrane and the **solubility** of the molecules in oil compared with water. (1)
- ..... (iii) Water is able to diffuse through a cell membrane, even though it is a polar molecule.
- On the graph, draw a circle, labelled W, to indicate the permeability of the cell membrane to water. The size of the circle should represent the size of the water molecule. (2)
- (iv) Use your knowledge of the structure and properties of cell membranes to explain the results of this investigation. (3)