1)

Cardiovascular diseases are very common in the Western World.

(a) Many cardiovascular diseases result from atherosclerosis.

Place a cross ☒ in the box next to the correct word or words to complete each of the following statements.

(i) Atherosclerosis usually results from the formation of plaques inside

- ☐ **A** arteries
- ☐ **B** capillaries
- ☐ **C** veins
- ☐ **D** ventricles

(1)

(ii) The plaques begin to form after damage to

- ☐ **A** endothelial cells
- ☐ **B** epidermal cells
- ☐ **C** red blood cells
- ☐ **D** white blood cells

(1)

(iii) These cells may be damaged due to

- ☐ **A** blood flowing slowly under low pressure
- ☐ **B** blood flowing quickly under low pressure
- ☐ **C** blood flowing slowly under high pressure
- ☐ **D** blood flowing quickly under high pressure

(1)

(iv) The plaque consists of

- ☐ **A** carbohydrate deposits
- ☐ **B** fatty deposits
- ☐ **C** plasma deposits
- ☐ **D** protein deposits

(1)

(v) The presence of a plaque in the vessels supplying blood to the brain could result in

- ☐ **A** cancer
- ☐ **B** a heart attack
- ☐ **C** kidney damage
- ☐ **D** a stroke

(1)

2)

Thalassaemia is the name of a group of inherited blood disorders that affect the body's ability to produce haemoglobin in red blood cells. Red blood cells are produced in bone marrow.

Oxygen in the lungs binds to haemoglobin and is carried to the cells of the body to be used in respiration.

Beta thalassaemia is the result of a mutation in the gene coding for the β chain of haemoglobin. If a person inherits gene mutations from both parents, this person will show symptoms of anaemia and will require blood transfusions. Symptoms of anaemia include tiredness and breathlessness.

*(a) Using the information given above and your knowledge of gene mutation, suggest why a person with beta thalassaemia has symptoms of anaemia.

(4)

(b) If the phenotypes of the parents are known, the probabilities of having a child with beta thalassaemia, an unaffected child or a child who is a carrier, can be calculated.

Complete the table below to show the results of these calculations.

(4)

Parent 1	Parent 2	Probability of having a child with beta thalassaemia	Probability of having an unaffected child	Probability of having a child who is a carrier
Unaffected	carrier	no chance	50%	50%
Carrier	carrier			
Unaffected	has beta thalassaemia			
Carrier	has beta thalassaemia	50%	no chance	50%

(c) Gene therapy could potentially be used to treat beta thalassaemia.

Suggest how gene therapy could be carried out to treat this disorder.

(4)

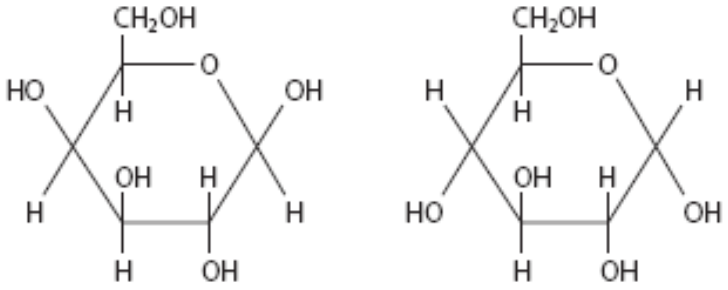
.....

3)

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)

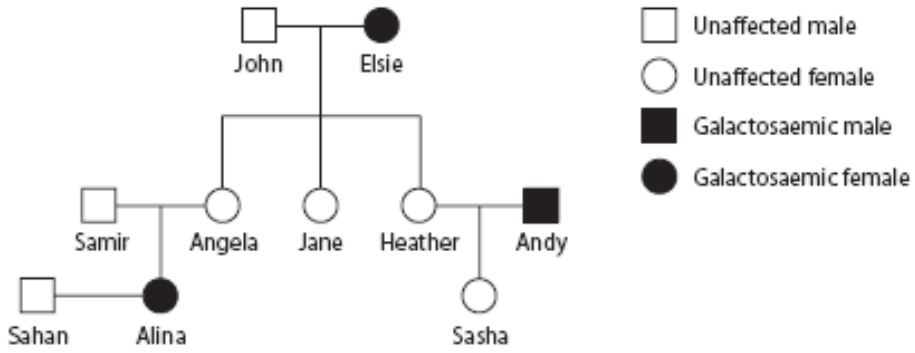
.....

(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)

4)

Cystic fibrosis is a genetic disease that can affect many body systems, including the digestive system. In a carrier of this disorder, preimplantation genetic diagnosis can be used to detect the presence of an allele for cystic fibrosis.

*(a) Explain how cystic fibrosis affects the digestive system.

(4)

(b) Explain how **preimplantation** genetic diagnosis is performed to detect cystic fibrosis.

(3)

(c) Discuss either **one** ethical issue or **one** social issue relating to the use of preimplantation genetic diagnosis.

(2)

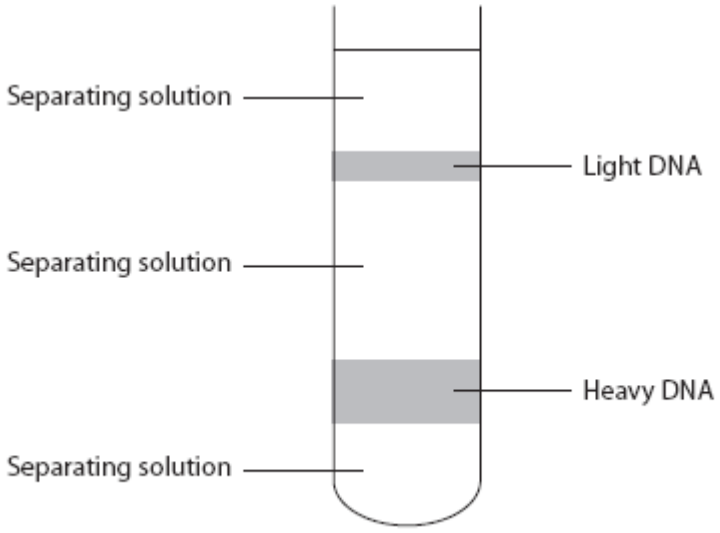
5)

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)

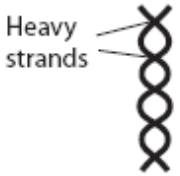
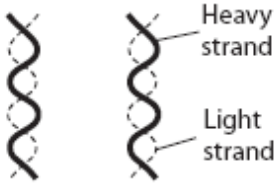
(b) Meselson and Stahl's experiments involved growing bacteria in culture media containing either heavy nitrogen (^{15}N) or light nitrogen (^{14}N). The DNA was then extracted from the bacteria. The DNA was analysed as shown in the diagram below.



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
Stage 1 Bacteria grown for several generations in culture medium containing heavy nitrogen		
Stage 2 The bacteria from the end of stage 1 were grown for another generation in culture medium containing light nitrogen		
Stage 3 The bacteria from the end of stage 2 were grown for one more generation in culture medium containing light nitrogen		

6)

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 AGA, AGG — Arginine	CGU, CGC, CGA, CGG — Arginine	GGU, GGC, GGA, GGG — Glycine	UGU, UGC — Cysteine UGA — Stop UGG — Tryptophan
AUU, AUC, AUA — Isoleucine AUG — Methionine	CUU, CUC, CUA, CUG — Leucine	GUU, GUC, GUA, GUG — Valine	UUU, UUC — Phenylalanine 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.

(1)

☐ **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

(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.

(1)

☐ **A** proline lysine alanine valine

☐ **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

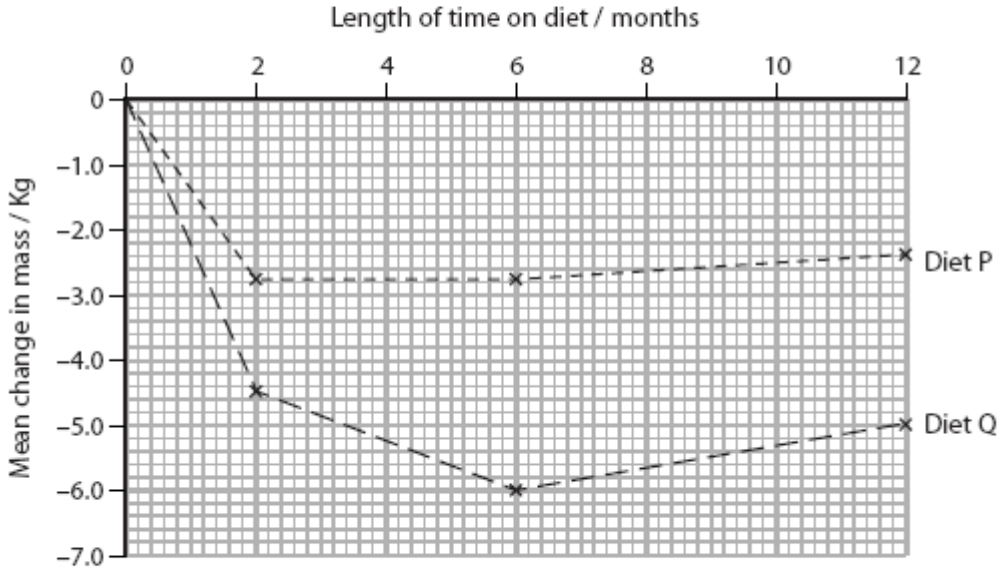
7)

Many different diets are available for people who want to lose weight. There is a lot of confusion over the merits of each one.

A scientist carried out an investigation to compare the effects of diet P and diet Q, on volunteers.

The changes in mass of two groups of volunteers on each of these diets were monitored over a 12-month period.

The graph below shows the mean changes in mass for each group of volunteers.



(a) (i) Compare the mean change in mass, over the first 6 months, for these two groups of volunteers.

(3)

(ii) Suggest why there was an increase in the mean mass of the volunteers on both diets between 6 months and 12 months.

(1)

.....

.....

(iii) State **two** variables that the scientist needed to control in this investigation.

(2)

1 .....

2 .....

(b) Suggest why exercise is usually included as part of a weight loss programme.

(3)

8)

Proteins, such as enzymes, are important molecules found in all living organisms.

(a) Read through the following passage on the primary structure of proteins, then write on the dotted lines the most appropriate word or words to complete the passage.

(5)

Proteins are made of monomers called ..... . These monomers are joined together by ..... bonds, formed during ..... reactions.

Each monomer of a protein consists of a central carbon atom attached to a hydrogen atom, an R group, an ..... group and a ..... group. The sequence of monomers determines the primary structure of the protein.

(b) (i) Describe the three-dimensional (tertiary) structure of an enzyme.

(3)

(ii) Explain how the primary structure of an enzyme determines its three-dimensional (tertiary) structure and its properties.

(3)