

MATRIC LIFE SCIENCES PAPER 1 2009

Tissues, cells & molecular studies; Life systems

SECTION A**QUESTION 1**

1.1 Various possible options are provided as answers to the following questions. Choose the correct answer and write only the letter (A–D) next to the question number (1.1.1–1.1.5), for example 1.1.11 D.

1.1.1 Which of the following is NOT part of a deoxyribonucleic acid (DNA) molecule?

- A cytosine
- B adenine
- C uracil
- D guanine

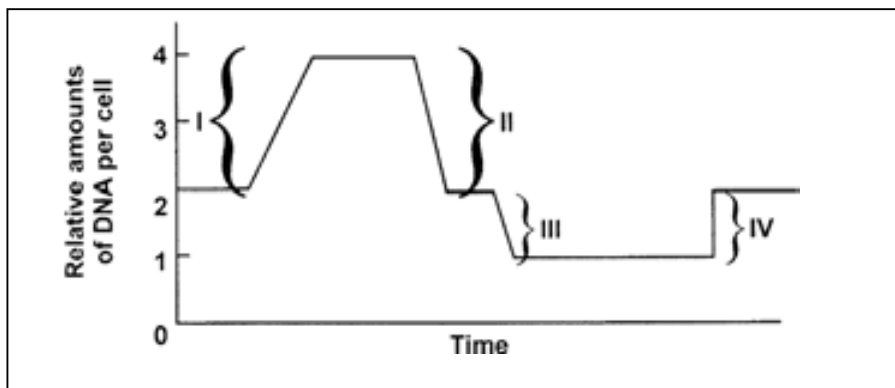
1.1.2 In pea plants the allele for flower colour (C) is dominant over the allele for lack of flower colour (c). A homozygous coloured plant was crossed with a plant bearing colourless flowers. The F₁ plants were then self-pollinated. Which of the following correctly represents the genotypic ratio expected in the F₂ generation?

- A All Cc
- B 1CC:1Cc
- C 3CC:1cc
- D 1CC:2Cc:1cc

1.1.3 The stage of meiosis which leads to genetic variation is

- A prophase I
- B telophase I
- C interphase
- D prophase II.

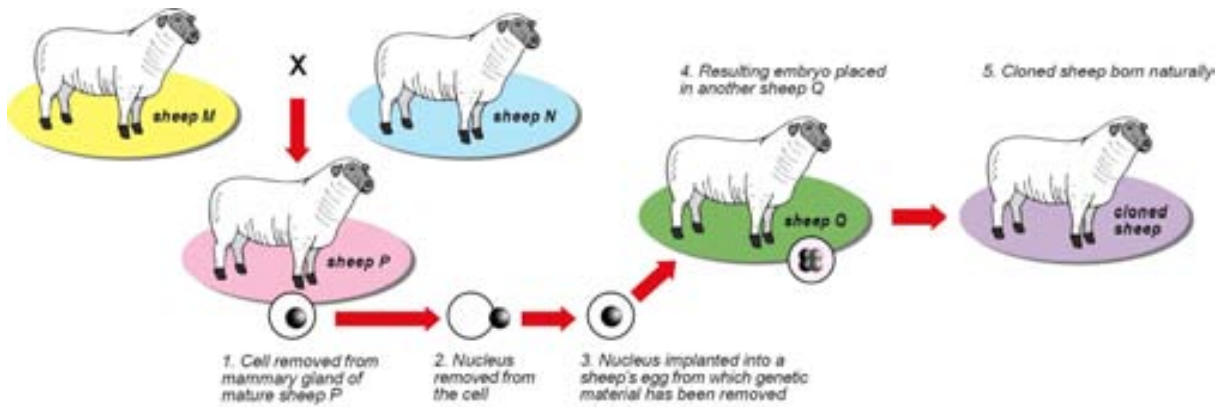
1.1.4 The graph below shows changes in the relative amounts of DNA per cell during a series of cellular events in a mammal.



Which one of the following combinations correctly describes the events shown on the graph?

	I	II	III	IV
A	DNA replication	mitosis	meiosis	fertilisation
B	DNA replication	meiosis I	meiosis II	fertilisation
C	mitosis	meiosis I	meiosis II	DNA replication
D	fertilisation	meiosis	mitosis	DNA replication

1.1.5 The following diagram summarises the steps involved in the production of a cloned sheep.



The chromosomes in the cells of the cloned sheep will be identical to those of

- A sheep M
- B sheep N
- C sheep P
- D sheep Q.

(5 x 2) (10)

1.2 Give the correct biological term for each of the following descriptions.
Write only the term next to the question number (1.2.1–1.2.8).

- 1.2.1 The position where chromatids of homologous chromosomes cross over during meiosis
- 1.2.2 An individual with unlike alleles for a particular characteristic
- 1.2.3 The appearance of an organism due to its genetic makeup
- 1.2.4 A pair of chromosomes that are identical in size
- 1.2.5 The process during which amniotic fluid is withdrawn to test for abnormalities of a foetus
- 1.2.6 The hormone responsible for milk production after birth
- 1.2.7 The meiotic process during which male gametes are formed in humans
- 1.2.8 Changes in the structure of DNA which can be harmful or beneficial

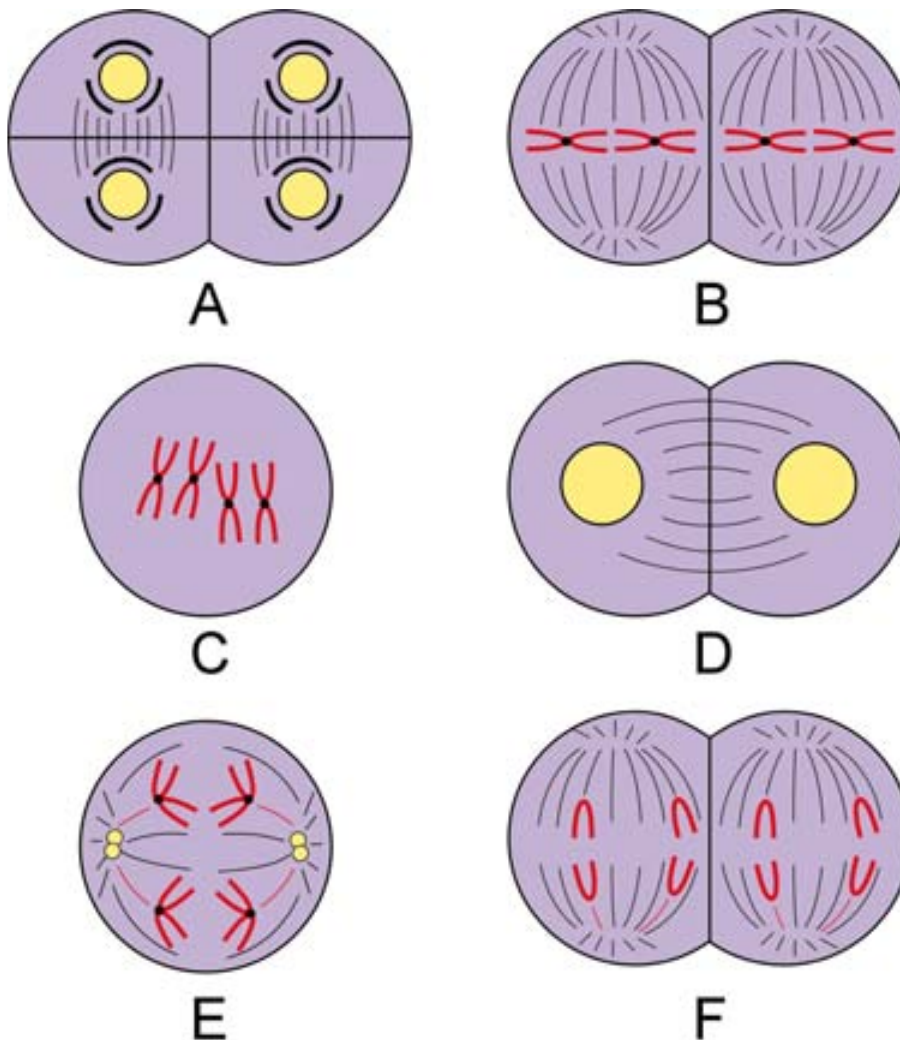
8 x 1 (8)

- 1.3 Choose an item from COLUMN II that matches a statement in COLUMN I. Write only the letter (A–E) next to the question number (1.3.1–1.3.5), for example 1.3.6 J.

	COLUMN I	COLUMN II
1.3.1	The part of a flowering plant that receives the pollen during pollination	A cytokinesis
1.3.2	Horizontal “stem” that spreads along the ground	B sperm duct
1.3.3	A tube that carries sperm from the testes to the urethra	C stigma
1.3.4	The division of cytoplasm that occurs after a cell nucleus has divided	D Sertoli cells
1.3.5	Plays a role in the nutrition of human spermatozoa	E stolon

5 x 1 (5)

- 1.4 Specialised cells in the ovary and testis divide during the process of meiosis to produce gametes. A cell with a diploid number of 4 underwent meiosis. The following diagrams illustrate different stages during the complete meiotic division of this cell.



1.4.1 Place the stages in the correct order, commencing with the earliest stage of meiosis shown. Write down only the letters shown below each diagram (A–F). (6)

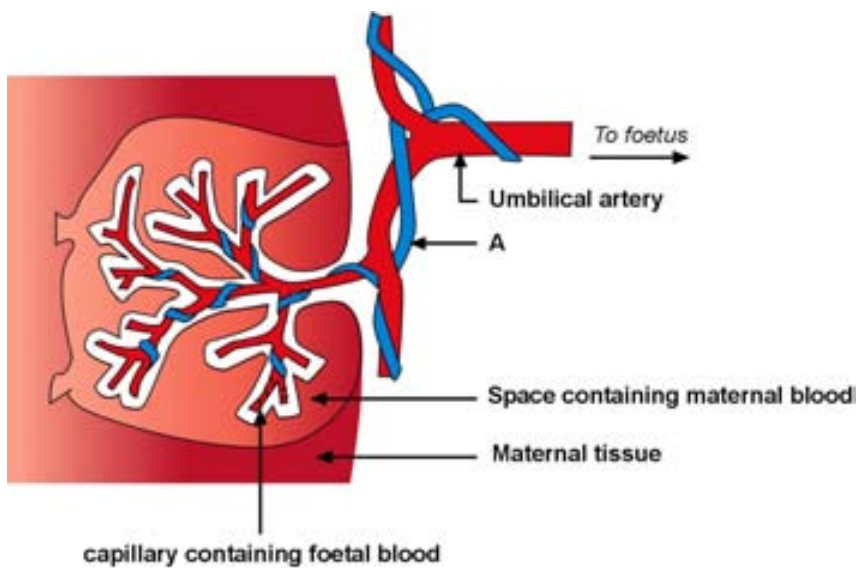
1.4.2 During meiosis, crossing over between homologous chromosomes occurs. Describe the outcome of crossing over. (2)

During meiosis the nucleus undergoes two divisions.

1.4.3 Which of the diagrams, E or F, represents anaphase I? (1)

1.4.4 Explain how you reached your answer to question 1.4.3. (2)

1.5 The diagram below shows the structure of part of a human placenta and umbilical cord. Study the diagram and answer the questions that follow.



1.5.1 Name structure A. (1)

1.5.2 Name two substances which would be present at a higher concentration in the umbilical artery than in the mother's blood. (2)

1.5.3 With reference to the diagram, suggest TWO ways in which the structure of the placenta enhances the transfer of substances between the blood of the foetus and that of the mother. (4)

- 1.6 The table shows the concentrations of selected sex hormones in the blood of a cow over a period of time. The menstrual cycle of a cow is controlled by the same hormones as in humans.

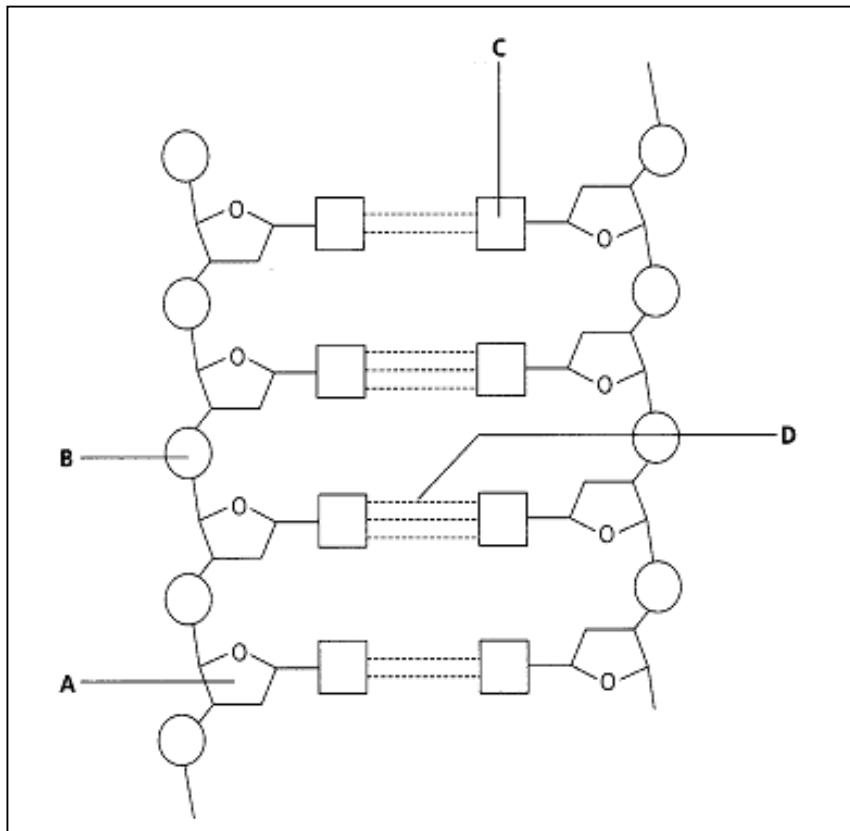
Time (days)	Concentration of hormone in the blood (arbitrary units)		
	Progesterone	Oestrogen	LH
0	1	14	32
2	2	8	1
4	4	7	1
6	10	7	1
8	14	7	1
10	18	7	1
12	19	7	1
14	19	7	1
16	18	7	1
18	8	18	1
20	1	14	32
22	1	8	32
24	2	8	1

- 1.6.1 Use the data in the table to estimate the length of the cow's menstrual cycle. Explain how you arrived at your answer. (2)
- 1.6.2 Explain how the high concentration of luteinising hormone (LH) facilitated the increase in progesterone over the ensuing days. (2)
- 1.6.3 The concentration of progesterone can be measured in milk. It gives a very early indication of whether a cow is pregnant. Why would it be an advantage for a farmer to know, as early as possible, whether a cow is pregnant? (2)
- 1.6.4 In some large dairy herds, cows are given growth hormones to increase their milk production. Do you think pregnant women should drink milk produced by these cows? Explain your answer. (3)
- [50]

SECTION B

QUESTION 2

2.1 The diagram below shows the structure of part of a DNA molecule.



2.1.1 Name the structures labelled A, B, C and D. (4)

2.1.2 What are the components of a nucleotide? (3)

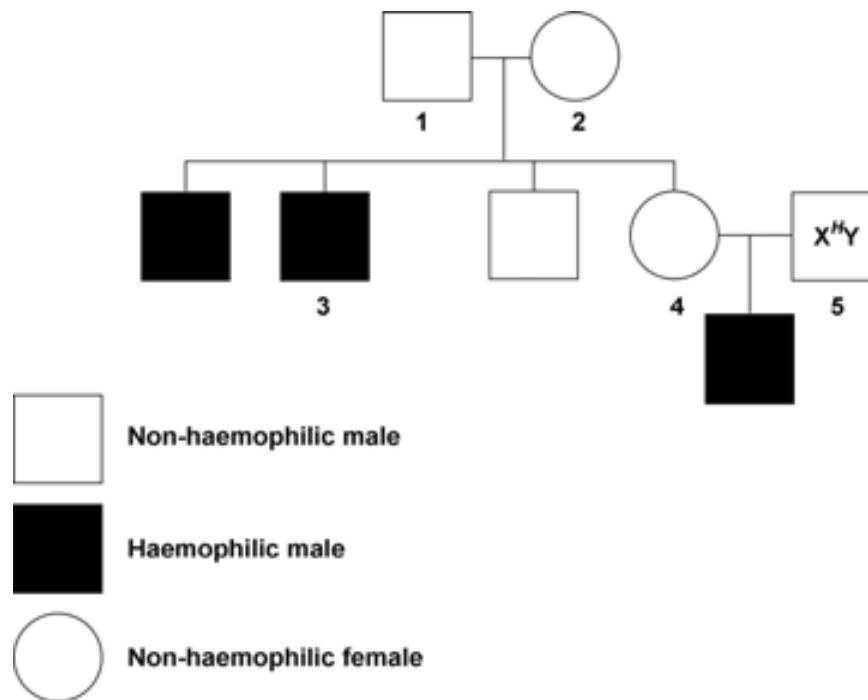
2.1.3 Tabulate THREE differences between DNA and ribonucleic acid (RNA). (7)

2.2 Learners wanted to investigate eye colour in fruit flies (*Drosophila melanogaster*). Fruit flies can have red (*R*) eyes or white (*r*) eyes. Red eye colour is the dominant trait, while white eye colour is the recessive trait. Male fruit flies, homozygous for red eyes, were bred with female fruit flies, homozygous for white eyes.

Show in a formal genetic diagram how the possible phenotypes and genotypes for eye colour of the F_1 generation may be obtained. (6)

2.3 In humans the gene responsible for blood clotting is carried on the X chromosome. Males who carry the recessive allele bleed easily and are called haemophiliacs. A female will only display haemophilia if she has two recessive alleles. The diagram below shows the occurrence of haemophiliacs in a certain family after surveys were carried out. The genotype of individual 5 is indicated in the diagram below.

Let H = normal clotting (X^H); h = haemophilia (X^h)



2.3.1 Write down the genotypes of individuals 1 to 4. (4)

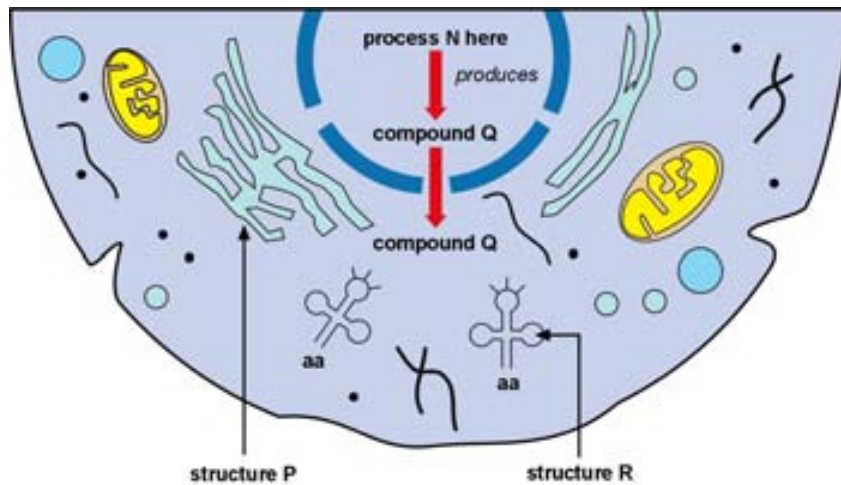
2.3.2 In another example, a haemophilic man is married to a non-haemophilic woman. They have three children: two sons, who are non-haemophilic, and a daughter who is a haemophiliac.

- Construct a pedigree diagram to illustrate this example, clearly indicating the genotype of the three children. (3)
- The mother is expecting another boy. What are the chances that this third son will be a haemophiliac? Explain your answer. Use a Punnett square to obtain your answer. (3)

[30]

QUESTION 3

3.1 The diagram below shows the overall process of protein synthesis.



3.1.1 Name process N and describe how mRNA (compound Q) was formed during process N. (5)

3.1.2 Identify structures P and R. (2)

3.1.3 Explain the role of structures P and R in translation. (4)

3.2 A group of Grade 12 learners conducted a survey regarding the frequency of genetic disorders in a small human population. The results are shown in the table below. The number of people in the population is 1 200.

RESULTS OF THE SURVEY ON THE FREQUENCY OF GENETIC DISORDERS IN A POPULATION

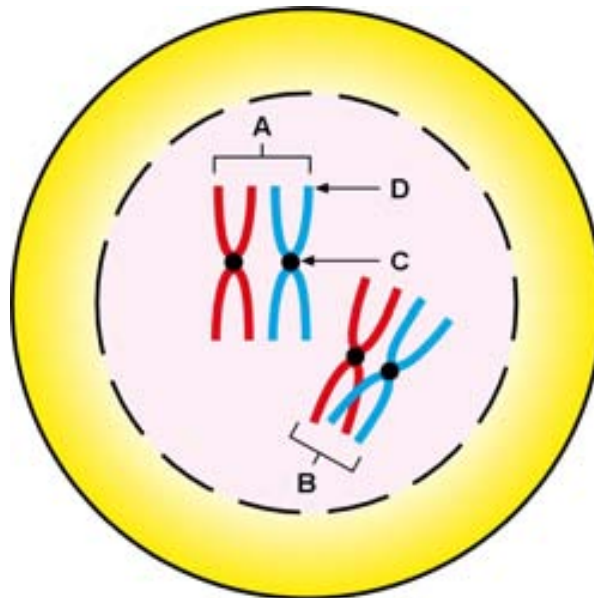
GENETIC DISORDERS	FREQUENCY IN POPULATION (%)
Albinism	7
Down's syndrome	x
Sickle cell anaemia	10
No genetic disorder	78

3.2.1 According to the table, which disorder is most common in this community?(1)

3.2.2 Calculate the number of people with Down's syndrome. Show ALL workings. (3)

3.2.3 Give ONE reason why genetic counselling would be important for parents who are expecting children that may suffer of a genetic disorder such as Down's syndrome. (2)

3.3 The diagram below represents a process that occurs during meiosis.



3.3.1 Provide labels for structures C and D. (2)

3.3.2 In a living cell, would structures A and B be visible with a microscope or would you be able to see them with the unaided eye? (1)

3.3.3 Name the process that is taking place at B. (1)

3.3.4 Give ONE reason why the process mentioned in QUESTION 3.3.3 is important. (2)

3.3.5 Draw a diagram of the structure labelled B to show its appearance immediately after the process in QUESTION 3.3.3 has occurred. (3)

3.4 The table below shows the success rate, in terms of live births, for in vitro fertilisation (IVF).

age of woman	percentage success rate of IVF
under 35	27.6
35 to 37	22.3
38 to 39	18.3
40 to 42	10.0
above 42	less than 5.0

3.4.1 Suggest reasons for the trends shown in the table. (2)

- 3.4.2 The cost of a single IVF treatment is about R25 000. In some countries, IVF is offered free of charge to couples who have not conceived within two years of trying. With **reference to the table above**, put forward an argument against the public funding of IVF for all couples who request it.

(2)

[30]

SECTION C

QUESTION 4

- 4.1 Records of human fertility for the period 1951–2000 have shown changes in the sperm counts of normal men. The table below summarises the changes in the percentage of men with high or low sperm counts over a period of 50 years.

TIME PERIOD	MEN WITH HIGH SPERM COUNTS (%)	MEN WITH LOW SPERM COUNTS (%)
1951–1960	40	3
1961–1970	35	7
1971–1980	26	15
1981–1990	19	18
1991–2000	13	25

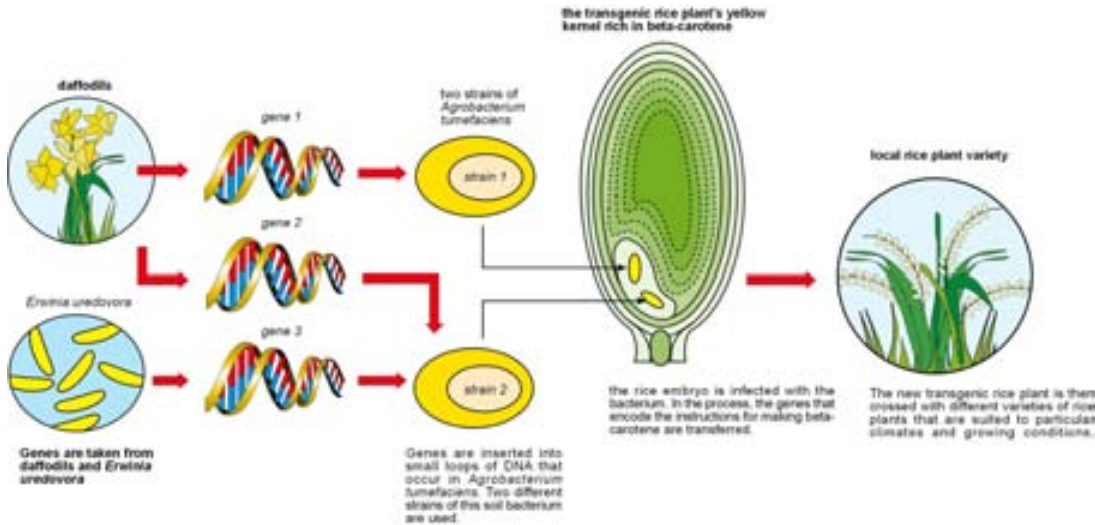
- 4.1.1 By how much did the percentage of men with high sperm counts decrease for the period 1951–1970? (1)
- 4.1.2 Describe the trend for men with low sperm counts and compare it to that of those with high sperm counts over the 50-year period. (2)
- 4.1.3 Give TWO possible reasons for the decline in male fertility over the 50-year period. (2)
- 4.1.4 On the same system of axes, draw TWO sets of bar graphs to compare the percentages of men with a high sperm count and those with a low sperm count for each decade between 1951 and 2000. (11)
- 4.2 Read the following text and answer the questions that follow. You may also have to draw on your own knowledge.

The miracle of golden rice

Over half the world's population depend on rice as their staple food. Polished white rice lacks beta-carotene, which is needed by the body to make Vitamin A. As a result, 140 million children on high white rice diets are at risk of vitamin A deficiency. This deficiency results in 500 000 cases of blindness each year. In 1999, a Swiss geneticist and a German botanist succeeded in transferring genes from a daffodil and a bacterium into the DNA of white rice plants. The new rice plant now produced yellow rice kernels, rich in beta-carotene. People eating this rice would be able to manufacture enough vitamin A in their bodies to stay healthy. The daffodil had two of the "right

genes” and they were inserted into the DNA of the rice plant. The third gene needed was carried by a harmless bacterium *Erwinia uredovora* and all three genes were inserted into the white rice DNA by a soil bacterium *Agrobacterium tumefaciens*.

Refer to the following diagram, which shows the process of transferring the genes to the white rice plant, to answer the questions that follow.



4.2.1 Use the information in the diagram above to draw a flow diagram to show how genetic engineers used the soil bacterium, *Agrobacterium tumefaciens*, to transfer genes 2 and 3 into rice plants in order to produce golden rice. (9)

4.2.2 There is much controversy around the production of genetically modified food, but the benefits may be enormous. Several factors need to be considered to decide if the production of golden rice is a viable project on a global scale:

- In 1999 yellow rice seeds cost three times that of white rice seeds, making it too expensive for rural farmers to buy.
- New seed has to be purchased every year as this rice is a sterile F₁ hybrid, which cannot reproduce.
- Yellow rice only grows under specific climatic conditions, while white rice grows under much wider climatic conditions.

The Tanzanian government decided to market golden rice to rural farmers. Write an essay explaining FOUR strategies you, as a government official, would use to promote this project. A local organisation, however, opposes this project. State FOUR arguments against the golden rice project. (15)

NOTE: NO marks will be awarded for answers in the form of diagrams.

[40]
GRAND TOTAL: 150