1. Read the following passage.

Despite its bad press, cholesterol is essential. We cannot manage without it. It is an important component of plasma membranes. Myelin, the substance surrounding many nerve fibres, is involved in the rapid conduction of nerve impulses and myelin is rich in cholesterol.

Being insoluble in water, cholesterol cannot be transported in solution in the blood plasma. Instead, it is packaged in lipoprotein particles. The main carrier of cholesterol is low-density lipoprotein (LDL). Each LDL particle has a cholesterol core protected by an outer coat and topped by a special protein molecule.

How is LDL-packaged cholesterol taken up by cells? Plasma membranes are studded with binding sites for this "topping" protein. These LDL receptors are made of protein with some sugar chains attached, and their numbers increase or decrease according to the cell's needs for cholesterol. After latching on to LDL receptors, LDL particles are pulled into the cytoplasm and processed in various ways. This regulatory mechanism, however, cannot control cholesterol concentrations outside cells when large amounts of cholesterol are present in the blood. The excess cholesterol is eventually deposited in artery walls. This leads to an increased risk of thrombosis.

In the 1980s, researchers purified the LDL receptor molecule and determined the sequence of its 839 amino acids. They also isolated the LDL receptor gene. Mutation of this gene gives rise to a condition known as familial hypercholesterolemia (FH). All the evidence we have, such as that all affected individuals have at least one affected parent, and that male to male transmission is possible, indicates that the mutant allele is dominant and located on one of the autosomes.

The FH allele is found in a high frequency in some populations. Among South African Afrikaners, for example, 1 in 100 are FH heterozygotes while 1 in 30 000 are homozygous for the FH allele. These people are all at risk of premature death from coronary heart disease.

Source: adapted from MANGE and MANGE, *Basic Human Genetics* (Sinaeur Associates Inc.) 1994

Use information from the passage and your own knowledge to answer the following questions.

(a) Explain how myelin is involved in the rapid conduction of nerve impulses (lines 2-3).

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(2)

(b) Describe how negative feedback is involved in controlling the concentration of cholesterol in the cytoplasm of a cell.

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(3)

(c) (i) Explain how a mutation of the LDL receptor gene can lead to a high concentration of cholesterol in the blood.

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(2)

(ii) Describe how excess cholesterol deposited in artery walls can lead to an increased risk of thrombosis (lines 14-15).

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(2)

(d) What is the minimum number of nucleotides in the mRNA molecule that codes for the LDL receptor? Explain how you arrived at your answer.

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(1)

(e) All individuals affected with FH have at least one affected parent (line 19).
Explain how this shows that the FH allele is *not recessive* to the normal allele.

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(2)

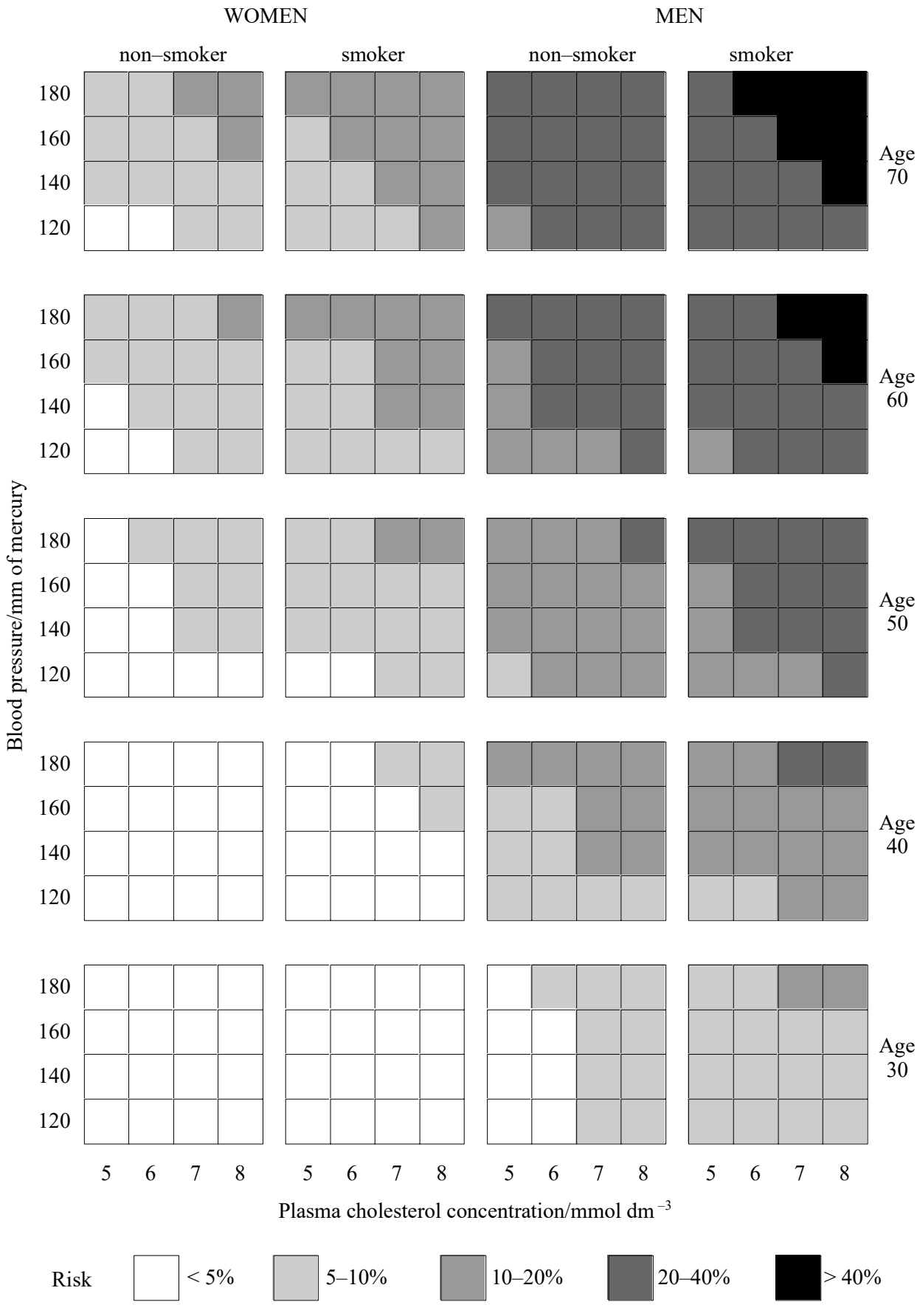
(f) Use the data in the last paragraph to estimate the number of people in the South African Afrikaner population at risk from premature death from coronary heart disease because of FH. Give your answer per 100 000 of the population. Show your working.

Answer ..... per 100 000

(3)

(Total 15 marks)

2. The chart shows the risk of developing coronary heart disease during the next ten years in relation to a number of risk factors.



(Adapted from *Odyssey, the Glaxo Weilcome Journal of Innovation in Healthcare* by permission of ExcerptaMedica.)

(a) According to the chart, what are the characteristics of the people with the highest risk of developing coronary heart disease?

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(2)

(b) Explain the relationship between the risk of developing coronary heart disease and

(i) plasma cholesterol;

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(2)

(ii) the sex of the person concerned.

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(1)

(c) Explain the limitations of using the chart as a method of prediction of the risk of developing coronary heart disease.

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(3)

(Total 8 marks)

3. Epidemiology has shown that there is a link between high fat diets and cancer of the colon, but this type of research tells us nothing about how such a diet actually causes the disease. More recently, investigators have tried to identify the events which take place before a malignant tumour develops. They have been looking for biological markers which show that there is an increased risk of cancer. Some of these markers are related to stages along the pathway from being exposed to a risk factor to developing cancer. These markers include particular chemicals attached to molecules of DNA, mutation of specific genes and abnormal cell growth. Other markers are associated with genetic factors such as inherited inefficiencies in destroying carcinogens, repairing DNA or in the way in which the immune system recognises tumour cells. This work has helped us to understand that malignant tumours usually arise from accumulated damage to the genes present in a single cell.

(a) The base sequence of a specific gene is known. Explain how a mutation of this gene could be detected in a sample of cells from human blood.

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(3)

(b) Suggest how the information acquired through research on biological markers could be used to reduce deaths from cancer.

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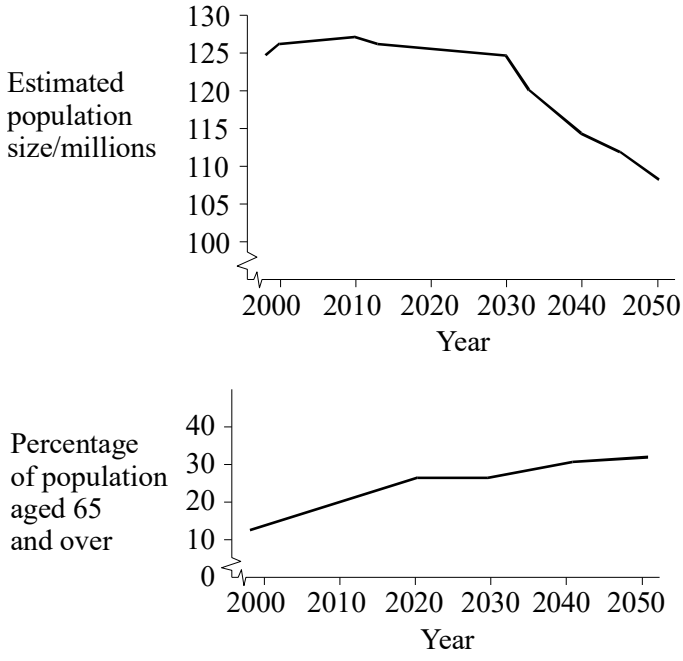
(3)
(Total 6 marks)

4. Read the following passage.

Japan may finally swallow the Pill

Three decades after the rest of the industrialised world, Japan has begun its final deliberations on whether to introduce contraceptive pills. Although they are currently banned in Japan, contraceptive pills are expected to be approved by government officials in June. The official explanation for the delay is that there are some concerns that oral contraceptives might encourage people to give up using condoms. However, many observers think that the real reasons behind the delay include the government's fears of a shrinking population. Women in Japan now have on average only 1.4 children each, one of the lowest rates in the world.

The graphs show projections for the size of the Japanese population and the proportion of the population aged 65 and over.



(a) Explain how oral contraceptives containing progesterone and oestrogen work.

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(5)

(b) Use the information given to evaluate the concerns about introducing oral contraceptives in Japan.

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(3)

(c) Assuming that the projected figures shown in the graph are accurate, explain how you would expect the population pyramid for Japan in 2050 to differ from that for 2000.

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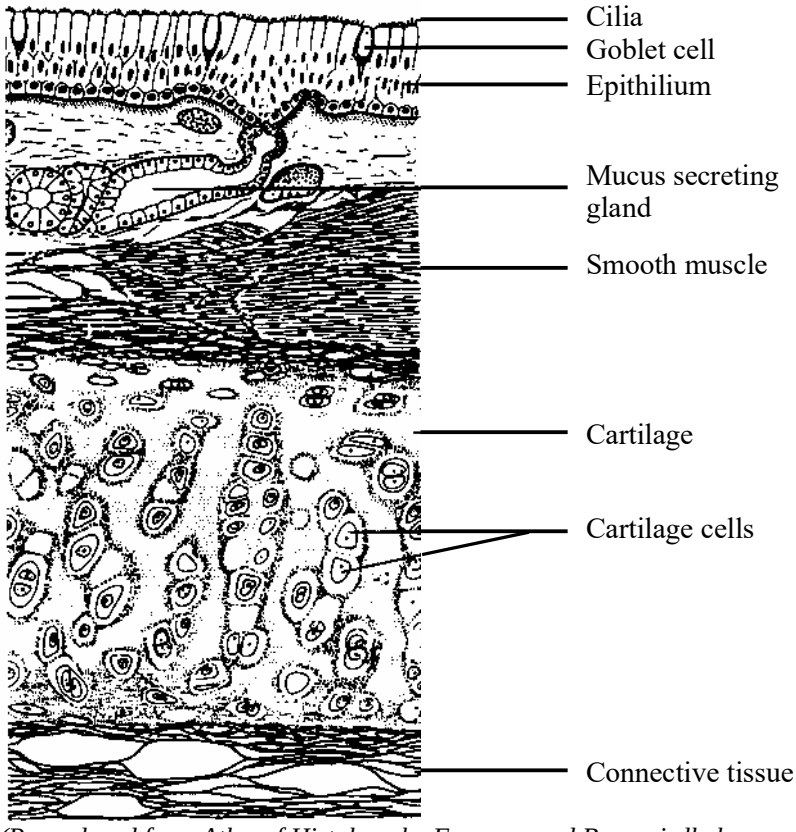
(4)
(Total 12 marks)

5. The diagram shows a section through the wall of a bronchus of a healthy person.



(Reproduced from Atlas of Histology by Freeman and Bracegirdle by permission of Heineman Educational Publishers)

(a) (i) Give **two** ways in which the bronchus shown in this diagram differs from a bronchus in a person suffering from chronic bronchitis.

1. .....

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2. .....

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(2)

(ii) Explain how each of these differences contributes towards the symptoms of chronic bronchitis.

1. .....

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2. .....

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(2)

(b) Suggest how the link between cigarette smoking and the incidence of chronic bronchitis could be investigated.

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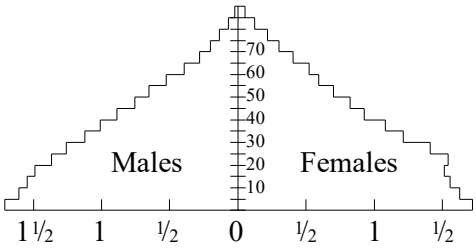
(3)

(Total 7 marks)

6. The diagram shows population pyramids for England and Wales in 1901, 1931 and 1956.

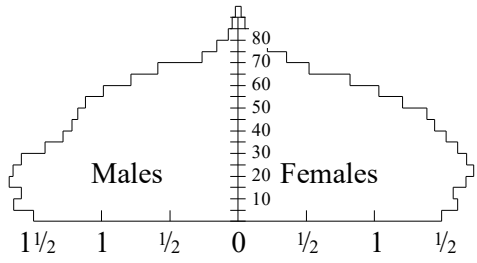
1901



Millions

Population pyramid 1901

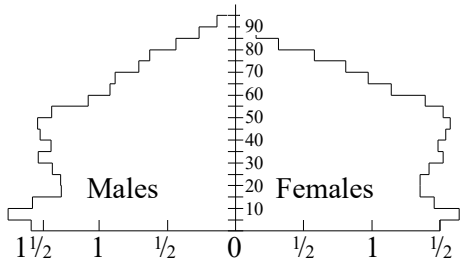
1931



Millions

Population pyramid 1931

1956



Millions

Population pyramid 1956

(a) To what extent do the data support the view that there was a decrease in birth rate between 1901 and 1931?

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(2)

(b) Describe and explain the change in life expectancy for 20 year olds which took place between 1901 and 1956.

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(2)
(Total 4 marks)

7. (a) (i) Explain how emphysema reduces the efficiency of gas exchange in the lungs.

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(2)

(ii) Give **two** factors, other than smoking, that could increase the incidence of emphysema.

1.....

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2.....

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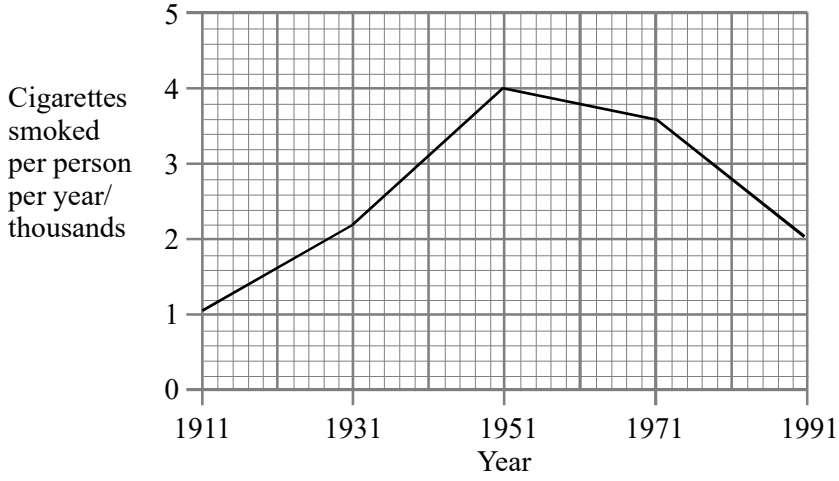
(2)

(b) The graph shows the mean number of cigarettes smoked per person per year from 1911 until 1991. The table shows the number of deaths from lung cancer during the same time period.



Year	Deaths per year from lung cancer
1911	600
1931	1500
1951	14000
1971	23000
1991	25000

(i) Describe the relationship between the data on the graph and the figures given in the table between 1911 and 1951.

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(1)

(ii) Suggest an explanation for the relationship between the data on the graph and the figures given in the table between 1951 and 1991.

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(1)

(c) Radon is a radioactive gas formed by the breakdown of radium. Suggest how inhaling radon may lead to the development of lung cancer.

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(3)

(Total 9 marks)

8. (a) Yellow fever is a viral disease which normally infects monkeys that live in tropical forests. It is transmitted from monkey to monkey by the forest-dwelling mosquito, *Aedes africanus.* Another species of mosquito, *A. simpsoni,* breeds in water in the leaf bases of banana plants. It also is able to transmit the disease.

Explain why the clearing of forests and planting of crops lead to an increase in the number of cases of yellow fever in the human population.

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(2)

(b) People can be immunised against yellow fever. They are given a vaccine containing an altered form of the virus. Explain how this vaccine prevents a person from developing yellow fever after being bitten by an infected mosquito.

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(2)

(c) Immunisation may be effective in controlling a disease even though some people have not been immunised against it. Explain how.

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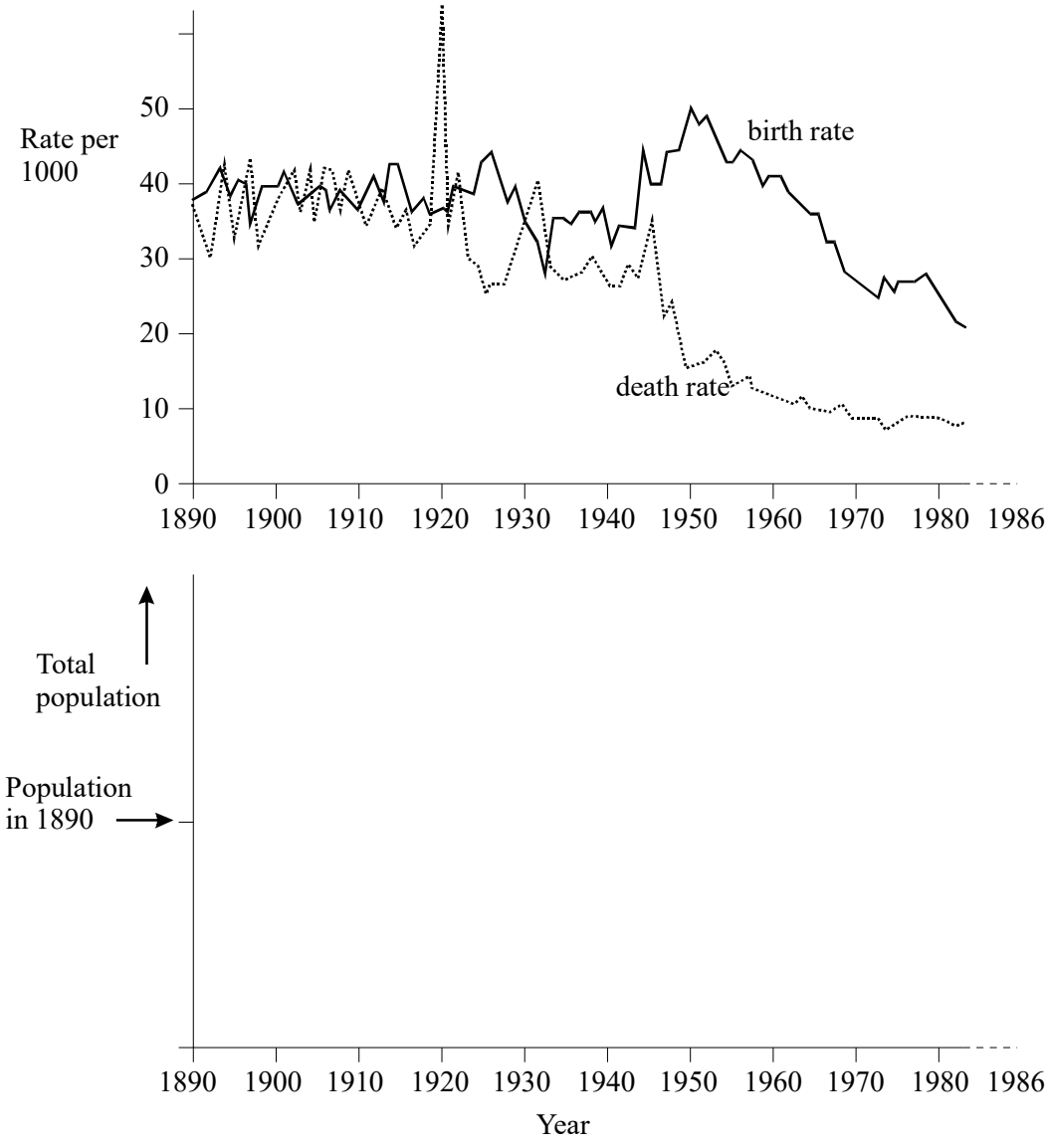
(2)
(Total 6 marks)

9. Mauritius is an island in the Indian Ocean. The graph shows the birth rate and the death rate for its human population between 1890 and 1986.



(a) (i) Using the information in the graph, sketch a curve showing the change in the total population of Mauritius between 1890 and 1986. Sketch your curve on the axes below the graph

(2)

(ii) You would need to know the birth rate and the death rate in order to calculate the population growth in a particular year. What other information would you need?

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(1)

(b) Before 1930, many deaths were due to infectious disease. Describe and explain **one** piece of evidence from the graph which supports this statement.

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(2)

(c) Give **one** way in which the demographic transition shown in this graph differs from that which occurred in the United Kingdom.

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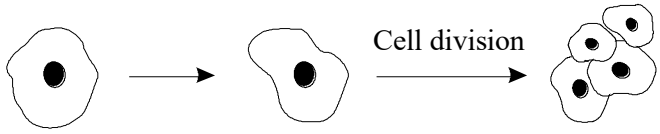
(1)
(Total 6 marks)

10. (a) The diagram shows how a tumour is produced from a single normal body cell.



(i) What type of cell division occurs when a cancerous cell develops into a tumour?

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(1)

(ii) Give **two** characteristics that would indicate that a group of cells is a tumour.

1 .....

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2 .....

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(2)

(b) (i) Explain how ultraviolet light may cause skin cancer.

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(1)

(ii) Suggest why the incidence of skin cancer is higher in Northern Australia than in Southern Australia.

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(1)
(Total 5 marks)

11. (a) Explain why atheroma may result in cardiovascular disease.

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(4)

(b) Three of the risk factors associated with the development of cardiovascular disease are eating a diet high in saturated fat, eating excessive quantities of salt and smoking.

Explain why these factors increase the risk of developing cardiovascular disease.

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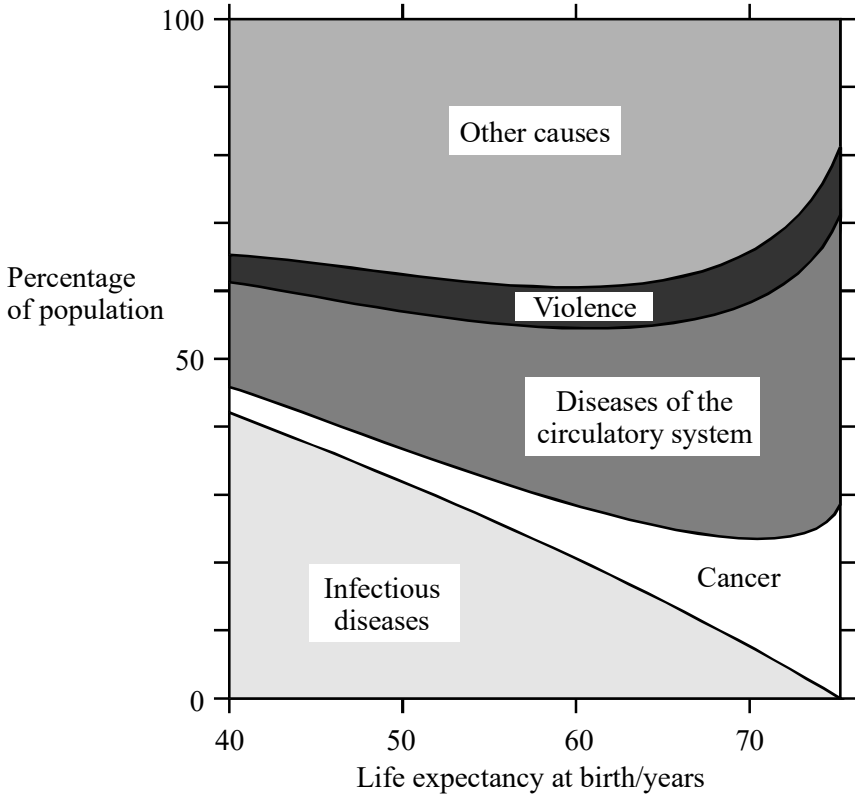
(8)
(Total 12 marks)

12. The diagram shows the percentage of deaths due to different causes in populations with different life expectancy at birth.



(a) (i) Sketch a survival curve for a population which has a life expectancy at birth of 40 years.

(1)

(ii) Sketch an age pyramid for a population which has a life expectancy at birth of 70 years.

(1)

(b) Using information from the diagram, explain how the quality of drinking water affects life expectancy at birth.

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(2)

(c) Suggest an explanation for the change in the percentage of deaths due to cancer shown in the diagram.

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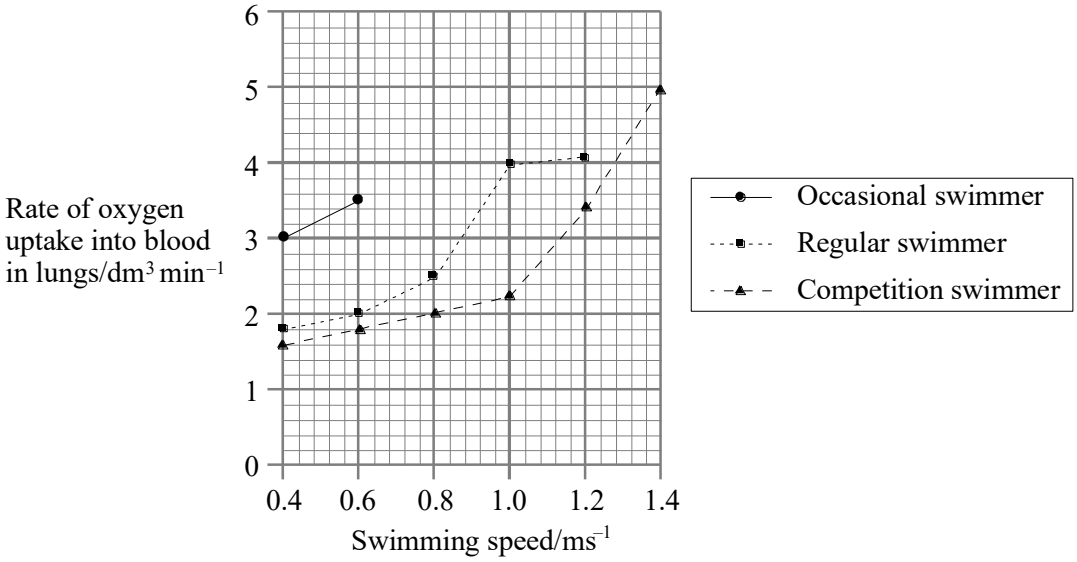
(2)
(Total 6 marks)

13. The graph shows the rate at which oxygen is taken into the blood in the lungs by three males swimming the same stroke.



(a) Calculate the volume of oxygen taken into the blood by the regular swimmer when swimming 300 metres at a speed of 0.6 m s^{-1}. Show your working.

Answer.....

(2)

(b) Suggest why measurements on the occasional swimmer were not made above a swimming speed of 0.6 m s^{-1}. You should **not** make reference to the age or health of the swimmer.

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(1)

(c) Use data from the graph to explain why the competition swimmer could produce a higher maximum swimming speed than the regular swimmer.

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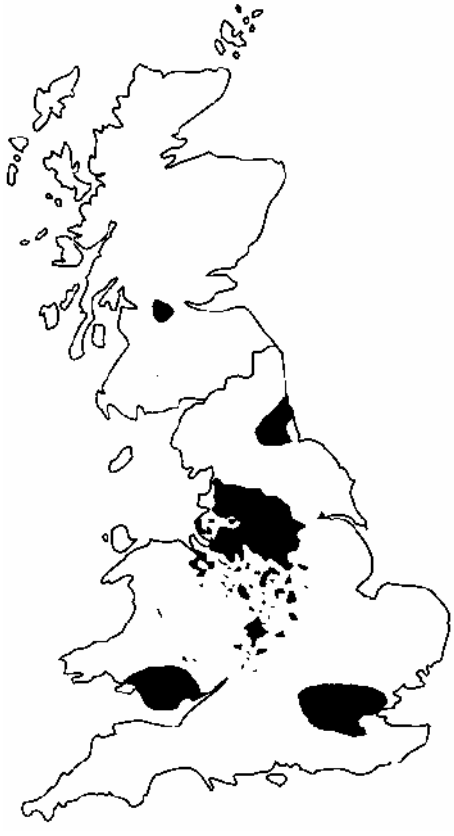
(3)
(Total 6 marks)

14. (a) The shaded areas on map **A** show parts of the UK where the incidence of chronic bronchitis is higher than average. Map **B** shows the positions of some major cities in the UK.

Map **A**



Map **B**

Suggest an explanation for the higher than average incidence of chronic bronchitis in the shaded areas on map **A**.

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(2)

(b) Explain what causes patients with severe bronchitis to breathe very rapidly when they walk uphill.

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(2)

(c) Give **two** differences between bronchitis and emphysema.

1.....

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2.....

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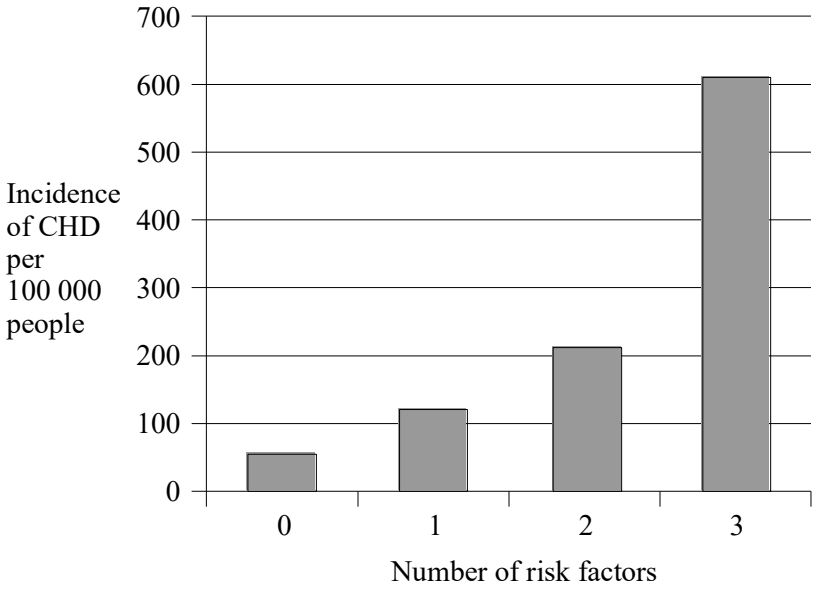
(2)
(Total 6 marks)

15. Several risk factors influence the onset of coronary heart disease (CHD). These include

- a blood cholesterol level greater than 2.5 g dm^{-3}
- blood pressure greater than 25 kPa;
- smoking more than 20 cigarettes per day.

The chart shows the effect of combining these three factors on the incidence of coronary heart disease.



(a) Describe the effect on the incidence of coronary heart disease of increasing the number of risk factors.

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(2)

(b) Explain how each of the following factors increases the risk of coronary heart disease.

(i) high blood cholesterol level

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(ii) high blood pressure

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(iii) heavy smoking

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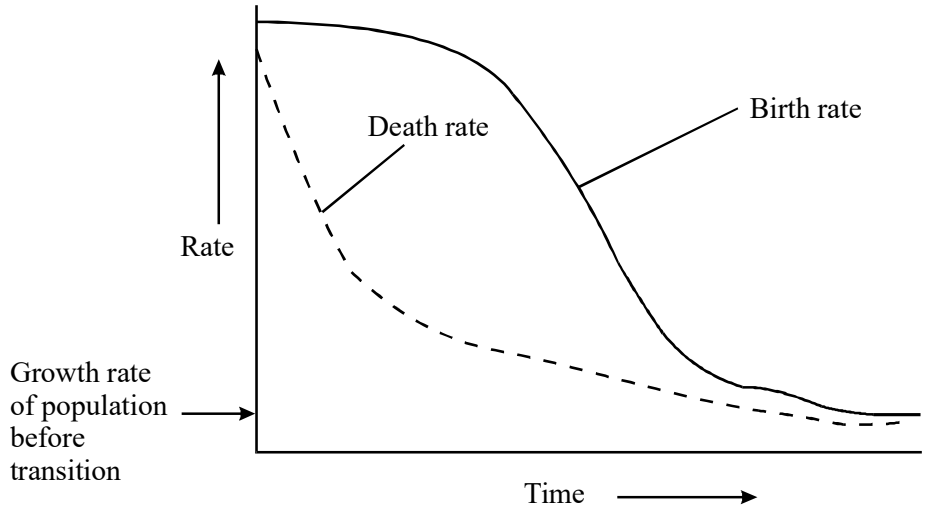
(10)
(Total 12 marks)

16. (a) The graph shows how the birth rate and death rate changed during a demographic transition in a human population.



(i) Explain how **two** changes in social conditions could have reduced the death rate.

1 .....

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2 .....

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(2)

(ii) Sketch a curve on the graph to show the growth rate of the population during the period shown. Start at the point indicated on the y-axis.

(1)

(b) In some countries AIDS has resulted in a very large increase in the death rate amongst children and young adults. What effect will this have on the shape of the age pyramid of these countries?

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(1)

S (c) There has been a rapid increase in the size of human populations during the past two centuries. Suggest **three** reasons why this has resulted in the reduction of populations of many other species.

1 .....

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2 .....

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3 .....

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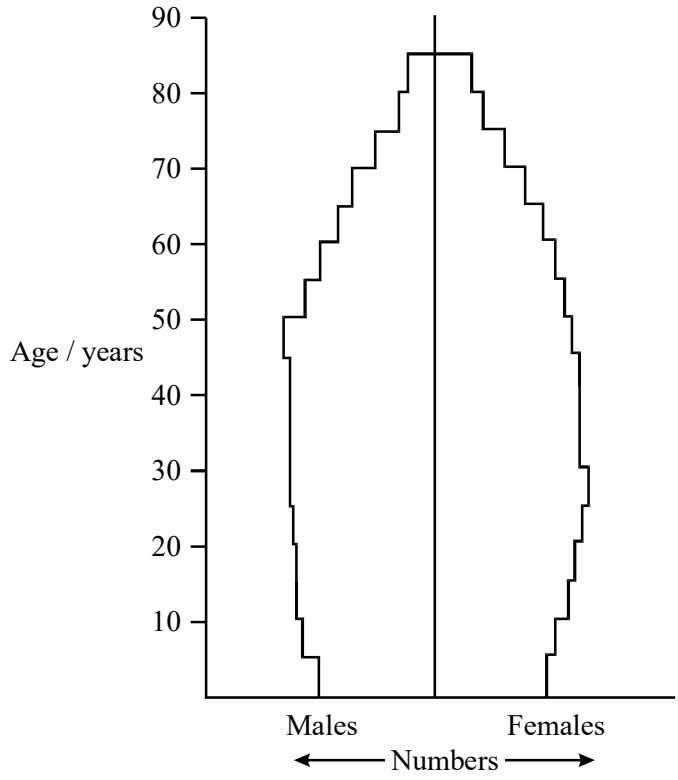
(3)
(Total 7 marks)

17. The table shows some information about the populations of Japan and Nigeria.

Country	**Population in 1999/ millions**	**Estimated population in 2015/ millions**	**Fertility rate/ children per woman**	**Life expectancy at birth/ years**	**Under-5 mortality/ deaths per 1000**
Japan	126.5	126.1	1.4	80	4
Nigeria	108.9	153.3	5.1	50	187

(a) The diagram shows a population pyramid for Japan in 1999.



On the diagram, sketch the population pyramid as you would expect it to appear in 2015.

(2)

(b) (i) Use information in the table to explain why the population of Nigeria is expected to increase to over 150 million by 2015.

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(2)

(ii) Suggest and explain **two** factors that could result in the actual increase in the population of Nigeria being less than estimated.

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2 .....

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(2)
(Total 6 marks)

18. Certain genes in the body, called tumour suppressor genes, normally prevent the uncontrolled growth and division of cells. Recent research has shown that tumours may develop when methyl groups (CH_3) attach to a tumour suppressor gene at certain positions. A strand of DNA which is complementary to a section of this tumour suppressor gene can be used to detect whether methyl groups have become attached. The strand only binds to the gene if no methyl groups are attached.

(a) Explain how the DNA strand would attach to a normal tumour suppressor gene.

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(3)

(b) A technique based on this research is being developed as a possible way of screening the adult population for the presence of cancer of the kidney. Special 'dipsticks' with DNA strands attached would be used to test for the presence of fragments of cancerous cells in urine.

Explain **two** factors that should be taken into account before introducing such a screening programme.

1 .....

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2 .....

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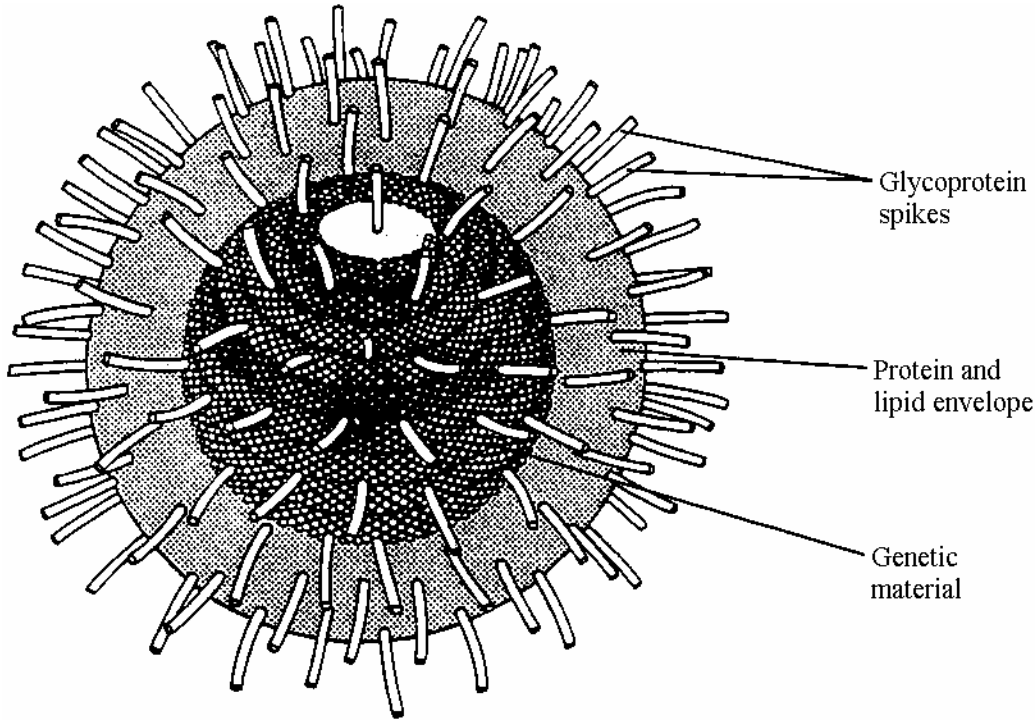
(2)
(Total 5 marks)

19. The diagram shows the virus which causes influenza.



The spikes on the surface of the virus are glycoproteins (proteins with attached sugars). These glycoproteins are the main antigens. The spikes attach to the surface membranes of the cells lining the trachea, bronchi and bronchioles. The virus is then taken into these cells. The virus replicates inside the cells, causing the cells to die and release large numbers of viruses.

S (a) Give **two** ways in which the structure of a bacterium differs from the structure of this virus.

1 .....

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2 .....

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(2)

(b) Explain how the influenza virus is transmitted from person to person.

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(2)

S (c) Sometimes a new strain of the influenza virus arises, in which the structure of the glycoproteins in the spikes is significantly changed. This new strain may cause an influenza epidemic.

Explain how the new strain may arise and why it may cause an epidemic.

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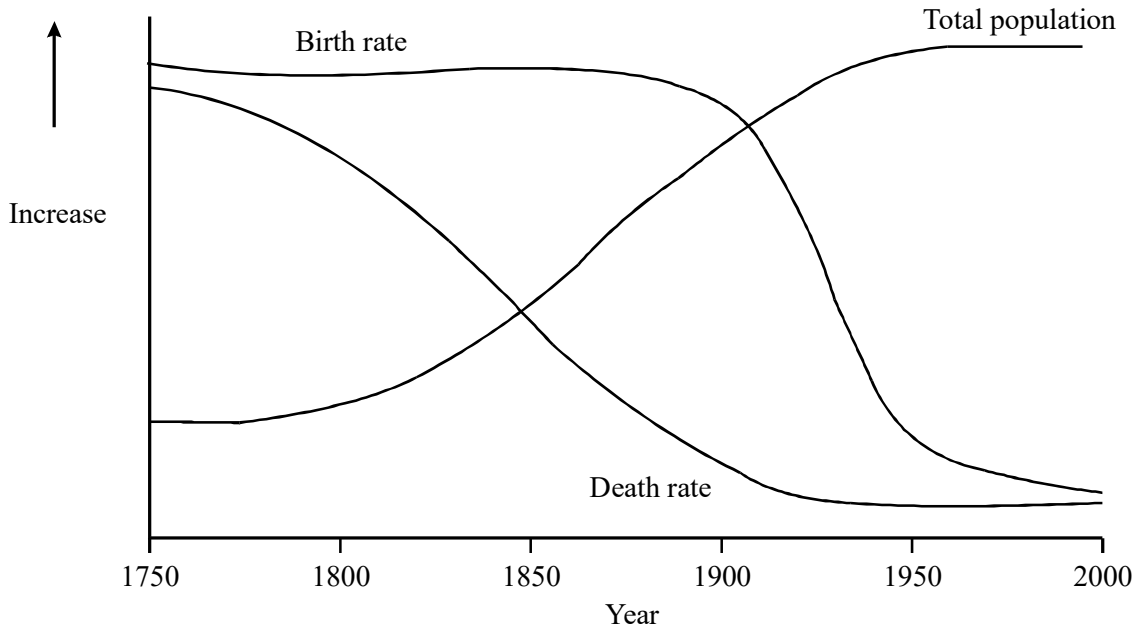
(6)
(Total 10 marks)

20. The graph shows changes in birth and death rates and the total human population in Britain over the last 250 years.



(a) Between 1750 and 1900 the death rate decreased, but the birth rate remained high.

Suggest an explanation for

(i) the decrease in death rate;

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(1)

(ii) the birth rate remaining high.

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(1)

(b) Using information in the graph, explain what is meant by *demographic transition*.

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(2)
(Total 4 marks)

21. (a) Describe how the growth of a malignant tumour in one organ can lead to tumours developing elsewhere in the body.

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(1)

The table shows the numbers of deaths of people aged under 65 years due to different cancers, in the UK in 1997.

Men		**Women**	
Cancer	**Number of deaths**	**Cancer**	**Number of deaths**
Lung	4013	Breast	4118
Colorectum	1691	Lung	2157
Lymphatic tissue	1607	Ovary	1313
Oesophagus	971	Colorectum	1133
Brain	845	Lymphatic tissue	1103
Others	6501	Others	5323
Total	15 628	Total	15 147

Source: Stationery Office Department of Health *Health and Personal Social Services Statistics* 1997

(b) (i) Calculate the percentage of deaths due to lung cancer. Show your working.

Answer .....

(2)

(ii) Suggest **one** reason for the difference between men and women in the number of deaths due to lung cancer.

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(1)

(c) Explain how excessive sunbathing can lead to malignant skin tumours.

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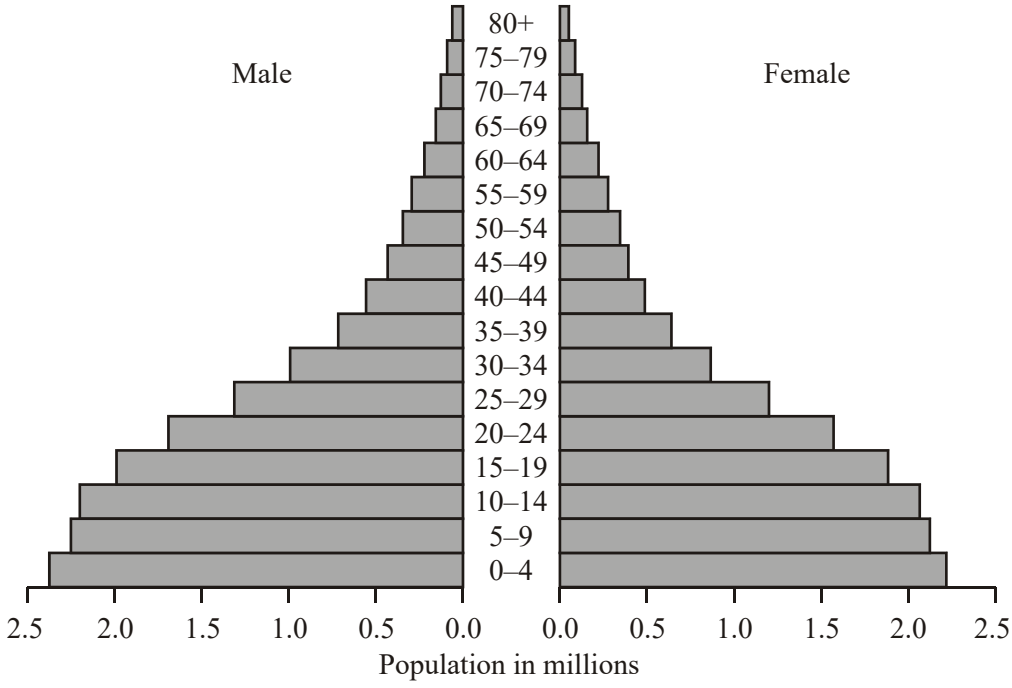
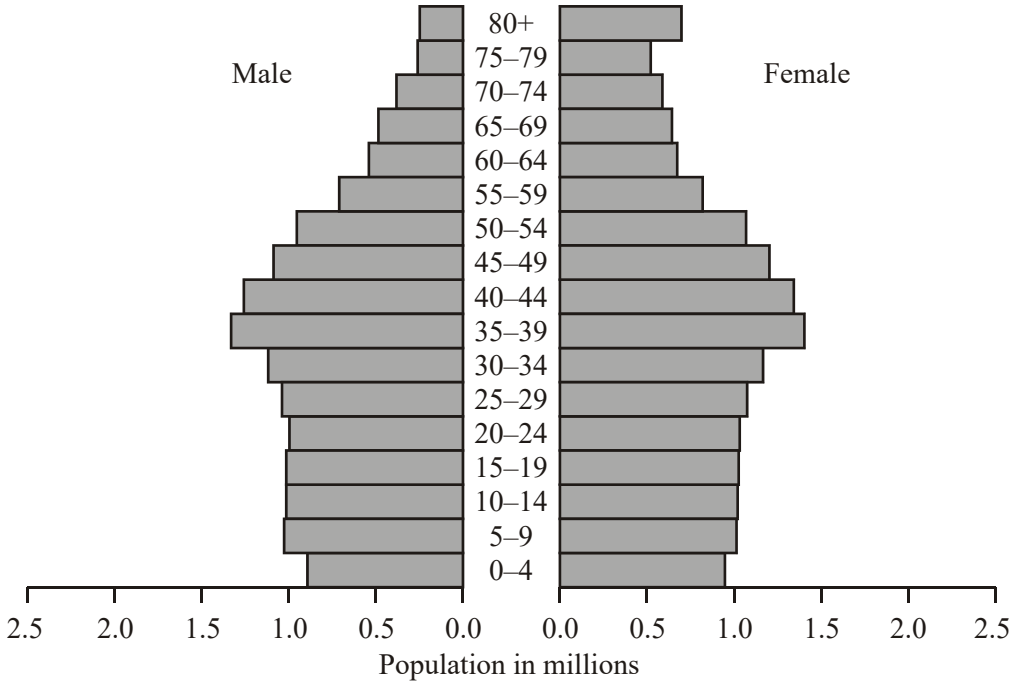
(3)

(Total 7 marks)

22. (a) The population pyramids show the age distribution in two countries in 2000.



Country A



Country B

(i) Describe the pattern of age distribution in each country.

Country A .....

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Country B .....

.....

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(2)

(ii) The population size of the two countries is about the same. In which country is the population growing more rapidly? Explain your answer.

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(1)

(b) What information is required in order to calculate the growth rate of a population?

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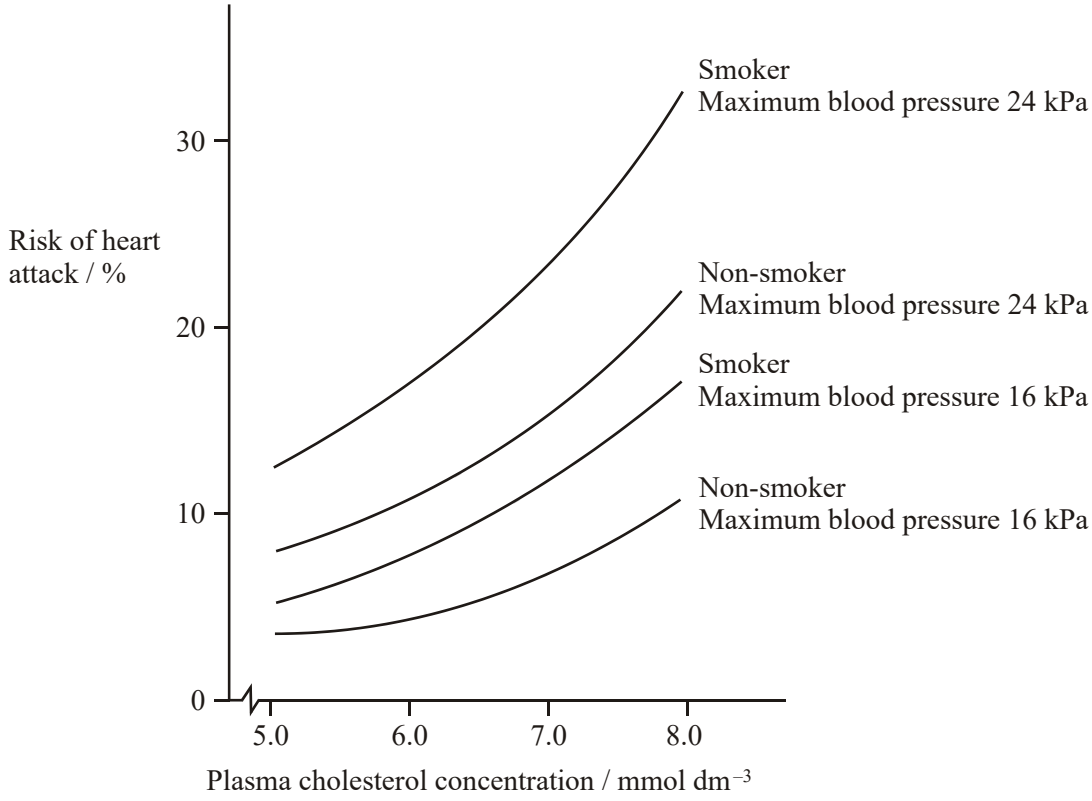
(2)

(Total 5 marks)

23. (a) The graph shows the risk of a 50-year-old male having a heart attack during the next ten years, in relation to several risk factors.



(i) Describe what the graph shows about the effect of smoking on the risk of having a heart attack.

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(2)

(ii) Explain why an increase in plasma cholesterol concentration increases the risk of a heart attack.

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(2)

S (b) Cigarette smoke contains nicotine. Nicotine stimulates the sympathetic nervous system and increases the stickiness of blood platelets.

Explain how these effects of nicotine increase the risk of cardiovascular disease.

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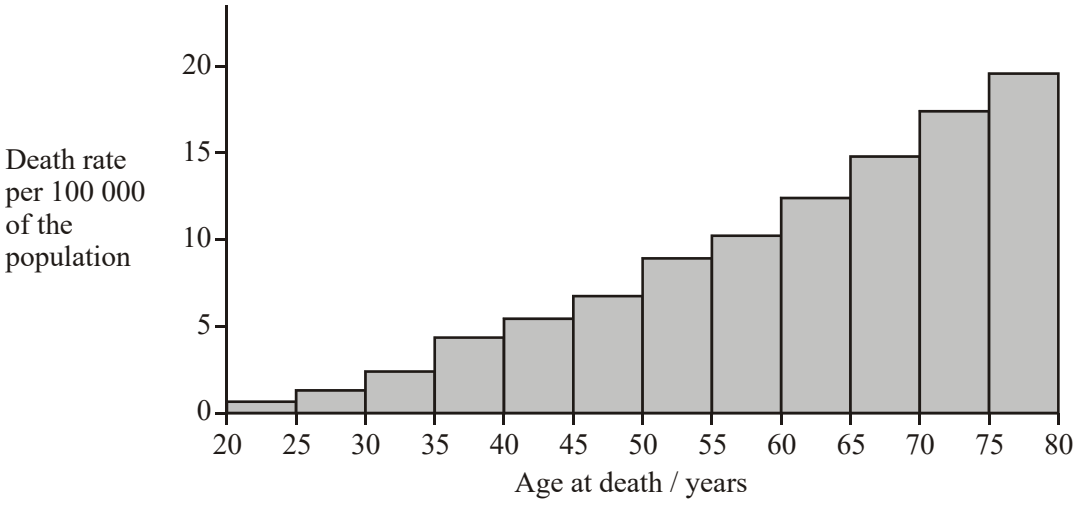
(4)

(Total 8 marks)

24. The death rate from malignant skin tumours was investigated in the USA. The graph shows the results for fair-skinned men in different age groups.



(a) Describe what is meant by a *malignant tumour*.

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(3)

(b) Give **one** reason for the change in death rate from malignant skin tumours with increasing age.

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(1)

(c) The data for fair-skinned and dark-skinned people were collected separately.
Explain why skin colour was a factor likely to affect the death rate.

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(2)
(Total 6 marks)

25. The table shows the birth rate, death rate and life expectancy in England and Wales in four different years. You may assume there was no migration.

Year	**1851**	**1901**	**1931**	**1961**
Birth rate per 1000 population	34.3	28.5	15.8	17.6
Death rate per 1000 population	22.0	16.9	12.3	11.9
Female life expectancy at birth / years	41.9	52.4	62.9	74.0
Male life expectancy at birth / years	39.9	48.5	58.7	68.1

(a) (i) Give the year when the population was growing at the slowest rate.
Explain your answer.

Year .....

Explanation .....

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(2)

(ii) The population of England and Wales in 1851 was 18 million. Calculate the size of the population in 1852. Show your working.

Answer .....

(2)

(b) One reason for the decrease in the death rate between 1851 and 1931 was the introduction of mass vaccination. Explain how vaccinating a large proportion of the population reduces the death rate.

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(2)

S (c) Suggest a genetic explanation for the difference in life expectancy of females and males.

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(3)

(Total 9 marks)

26. **Figure 1** represents human demographic transition.

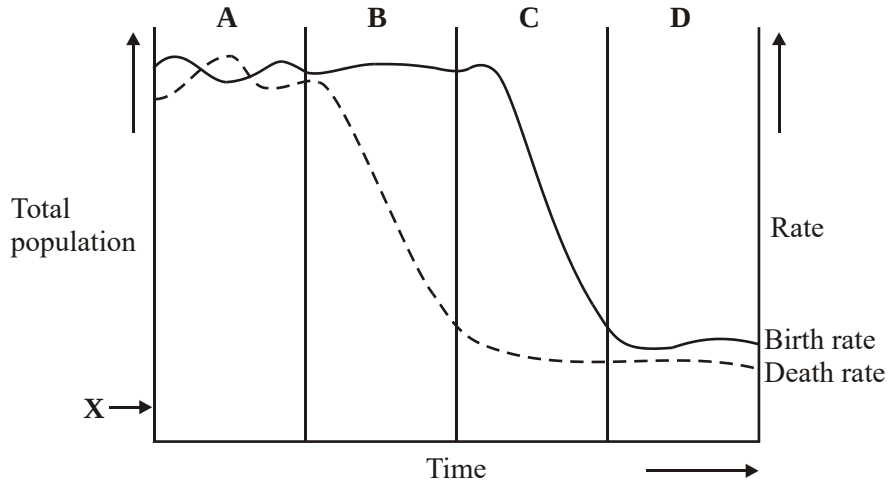

Figure 1

(a) Starting from the arrow labelled **X**, sketch a curve on the graph to represent the total human population over the time period shown.

(1)

(b) Give **two** possible explanations for the fluctuating death rate during stage **A**.

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2 .....

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(2)

(c) **Figure 2** is a simplified age pyramid.

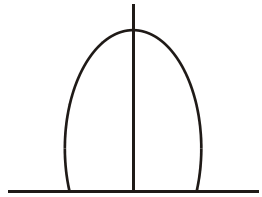

Figure 2

In **Figure 1**, in which stage, **A** – **D**, is the age pyramid the same shape as **Figure 2**?

Stage .....

(1)
(Total 4 marks)

27. One hypothesis for the cause of cancer of the colon (large intestine) is that *Clostridium* bacteria present in the gut can convert bile steroids into cancer-causing substances.

S (a) Explain the presence of bile in the colon.

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(2)

(b) The concentrations of bile steroids and numbers of *Clostridium* bacteria were measured in people with colon cancer and in controls without colon cancer. The table shows the results.

Concentration of bile steroids	**Number of *Clostridium* bacteria**	**Percentage of cancer patients**	**Percentage of controls**	**P**
high	high	76	9	<0.01
high	low	13	8	<0.01
low	high	7	34	<0.01
low	low	4	49	<0.01

A statistical test showed there was a significant difference between the cancer patients and the controls in each of the four categories.

(i) Explain how the results could be used to support the hypothesis that *Clostridium* bacteria convert bile steroids into substances which cause colon cancer.

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(2)

(ii) Explain how the results indicate that other factors may be involved in causing colon cancer.

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(1)

S (c) Human cells contain genes that control their growth and division. One of these genes codes for a protein that prevents cell division. The substances formed from bile steroids by *Clostridium* bacteria may cause gene mutation. Describe and explain how these substances could cause colon cancer.

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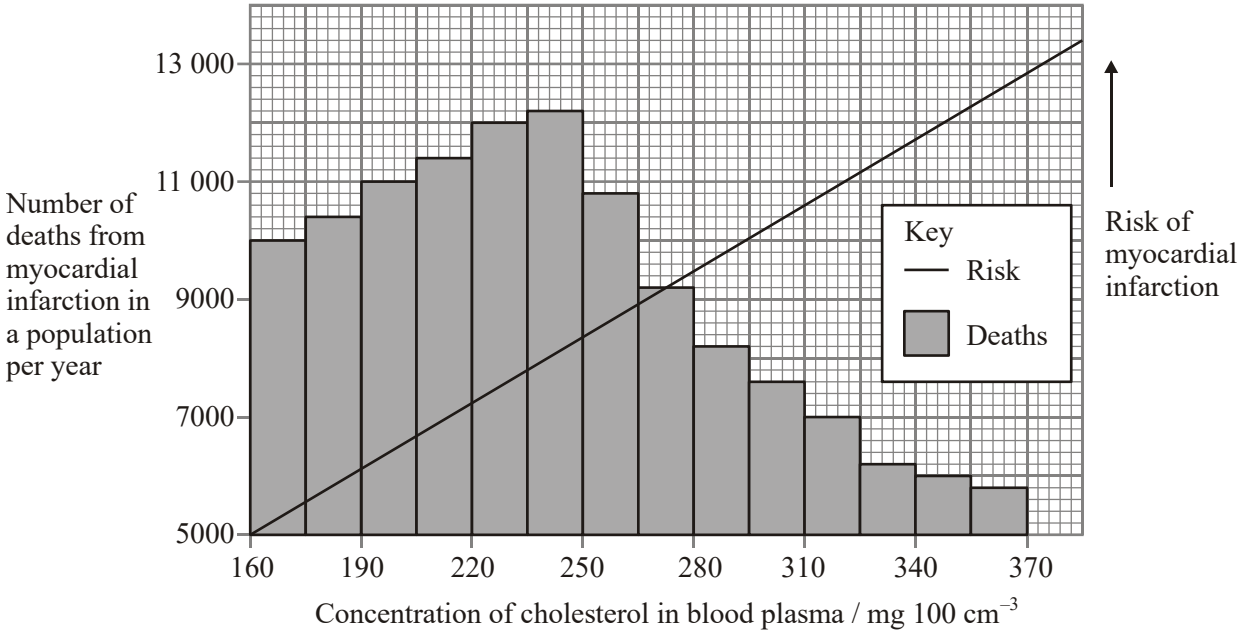
(4)

(Total 9 marks)

28. An increased concentration of cholesterol in the blood is one factor increasing the risk of myocardial infarction (heart attack). The graph shows the relationship between death from myocardial infarction and blood cholesterol concentration.



(a) (i) Describe how high concentrations of cholesterol in the blood can lead to disease of the blood vessels supplying the heart.

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(2)

(ii) Explain how disease of these blood vessels may lead to death from myocardial infarction.

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(3)

(b) The number of deaths from myocardial infarction decreased at concentrations of cholesterol above 250 mg 100 cm^{-3} blood whereas the risk of myocardial infarction continued to rise. Suggest an explanation for this difference.

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(2)
(Total 7 marks)

29. (a) In a demographic transition, give **one** factor that might cause

(i) an increase in the birth rate; .....

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(ii) a decrease in the death rate. .....

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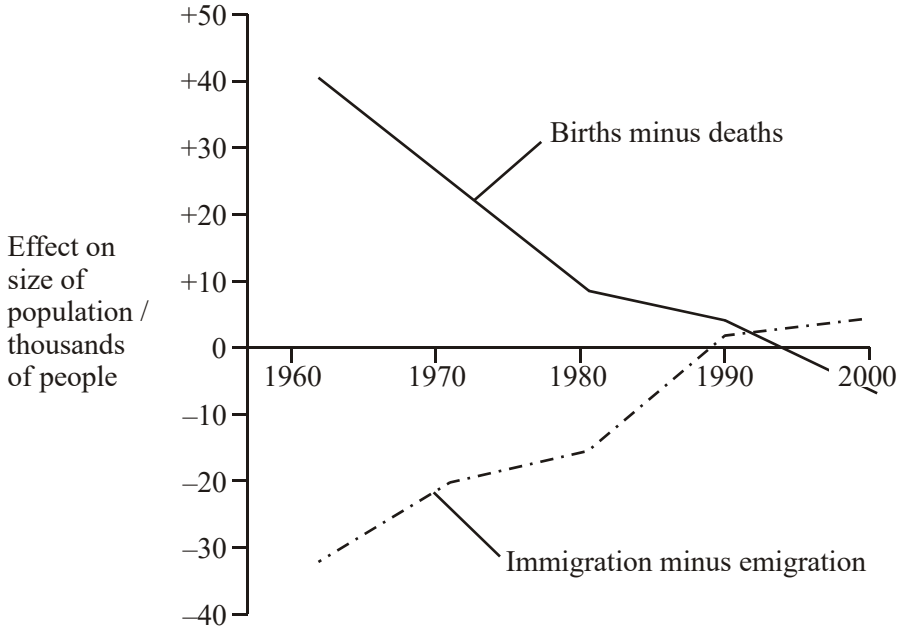
(2)

(b) Births, deaths and migration affect population growth. The graph shows the effects of these factors on a human population between 1960 and 2000. During this period the death rate was almost constant.



(i) From the information given, what does the graph show about changes in birth rate between 1960 and 1980? Explain your answer.

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(2)

(ii) Describe the effect of immigration and emigration on the growth of this population between 1960 and 2000.

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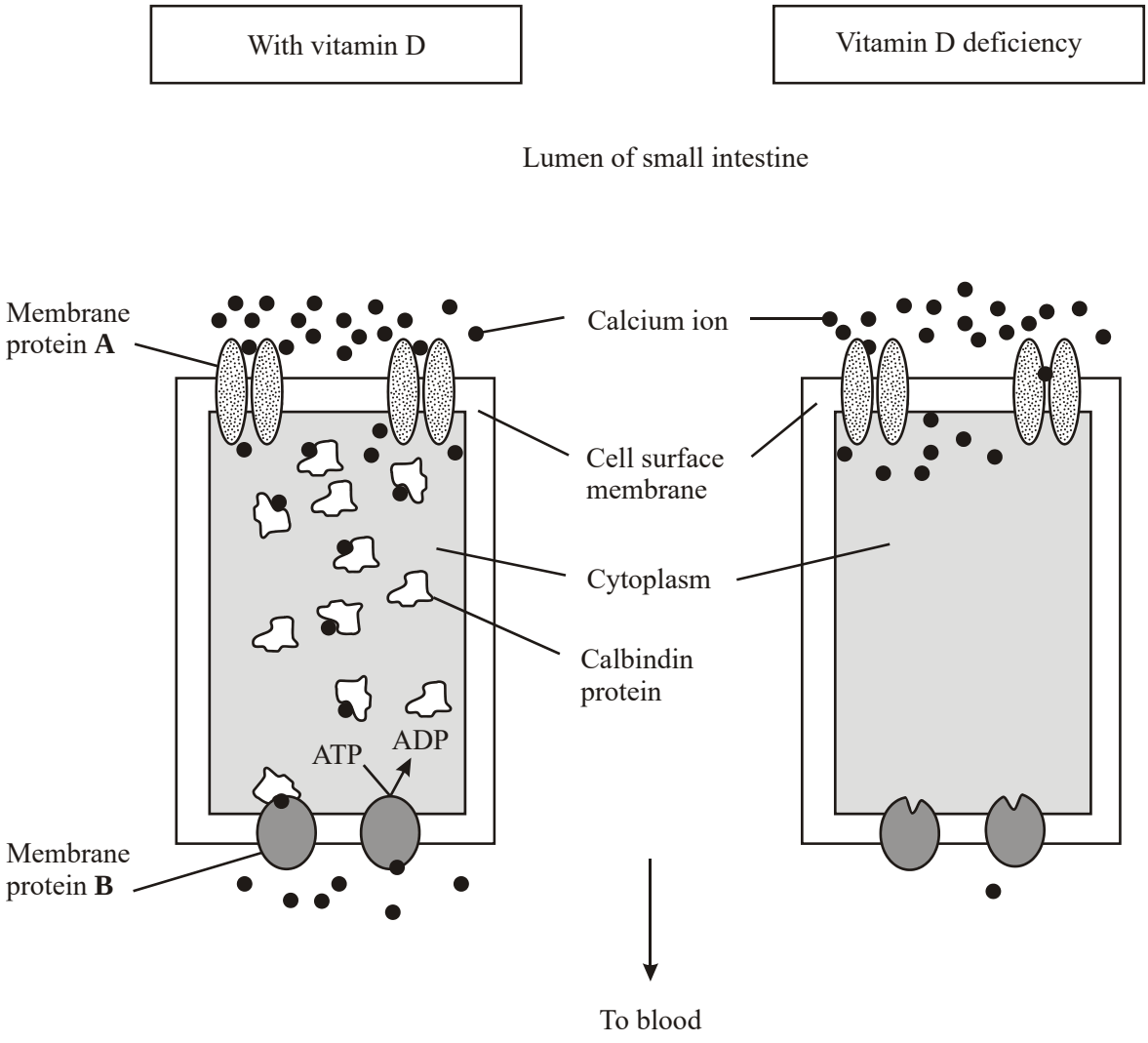
(2)

(Total 6 marks)

30. Vitamin D deficiency reduces the uptake of calcium ions by epithelial cells lining the small intestine. The diagrams show how calcium ions are transported through normal epithelial cells and those deficient in vitamin D.



(i) Use the information in the diagrams to explain how vitamin D deficiency reduces calcium ion uptake through gut epithelial cells.

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(2)

S (ii) Membrane proteins **A** and **B** transport calcium ions through cell surface membranes. Explain how each type of membrane protein transports calcium ions.

Protein **A** .....

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(2)

Protein **B** .....

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(2)

(Total 6 marks)