1. Scientists are conducting trials on a monoclonal antibody to treat cervical cancer by immunotherapy.

(i) Suggest how cancerous cells are targeted and destroyed by immunotherapy.

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[3]

(ii) Most cases of cervical cancer are caused by infection with Human Papilloma Virus (HPV) which is a sexually transmitted virus.

A vaccine to protect against HPV is now routinely offered to girls between the ages of 11 and 13.

For many people the vaccination is considered unethical.

Suggest **two** reasons why this vaccination programme may be considered unethical.

1

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2

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[2]

2.

(i) Leukaemia is a type of blood cancer.

**Fig. 5.3** shows how the number of cases of leukaemia varies with age at diagnosis.

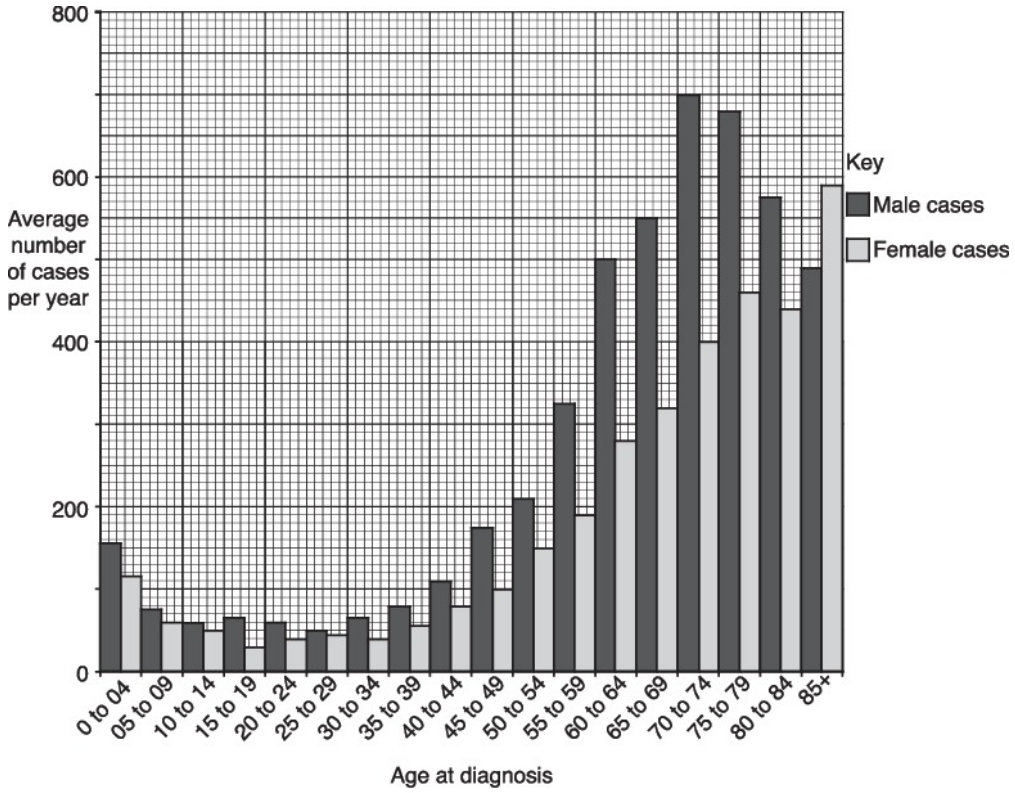


**Fig. 5.3**

Calculate the percentage difference in the mean number of cases per year between males and females at age 60–64 years.

Percentage difference _____ **[2]**

(ii) Using **Fig. 5.3**, evaluate the effect of age and gender as risk factors for leukaemia.

_____

_____

_____

_____

_____

[3]

3. Fungal allergens are carried mainly on fungal spores. Air samples taken in late summer and autumn (July to October) have the highest levels of fungal spores.

As part of a study, hospital admissions for asthma in different seasons for people in two different age groups were investigated.

The results are shown in Fig. 1.2.

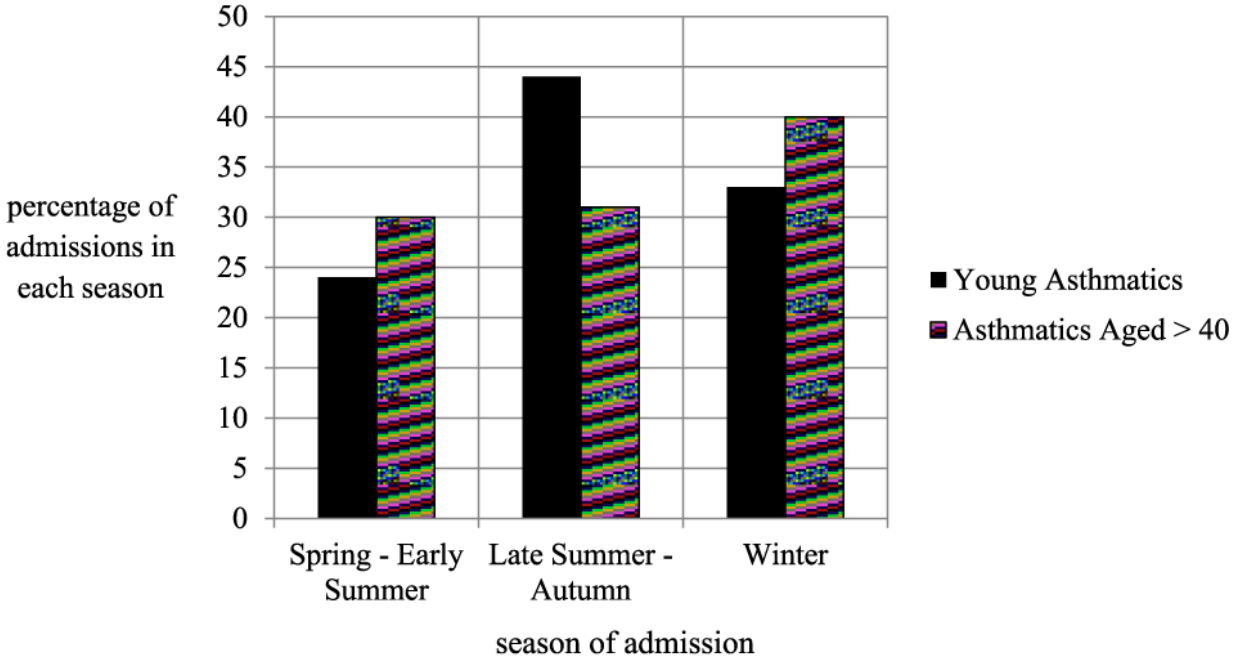


**Fig. 1.2**

(i) Asthma attacks are not only caused by fungal allergens. Severe asthma attacks during winter months, for example, are frequently associated with respiratory tract infections.

Suggest what other allergen might be responsible for severe asthma attacks during spring and early summer.

---------- [1]

(ii) By analysing the information in Fig. 1.2, what can you conclude about the effects of different allergens on asthma attacks in different age groups at different times of the year?

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[4]

4(a). This question is based on Case Study: **25 by 25**

The World Health Organisation (WHO) has set ambitious targets to reduce the number of deaths caused by non-communicable diseases (NCDs). This plan is known as the '25 by 25' NCD framework. The aim is to bring about a 25% reduction in premature mortality from NCDs between 2010 and 2025. The WHO has produced a list of 25 factors that can be used to assess the implementation of the plan.

The four main categories of NCD are:

- cancers
- cardiovascular diseases (CVD) (including coronary heart disease)
- diabetes
- chronic respiratory conditions (including asthma).

A research team has analysed the likelihood of lowering mortality for each NCD category. The scope for reducing deaths varies considerably between the categories of disease. The researchers have estimated the impact on NCD mortality if the WHO meets its targets for reducing the following six risk factors:

- tobacco use
- alcohol use
- salt intake
- obesity
- raised blood pressure
- raised blood glucose.

The research team predict that a 20% reduction in NCD mortality can be achieved by 2025 if the WHO targets are met for all six of the risk factors. They have calculated that a 34% decrease in deaths from cardiovascular diseases is possible. The researchers have estimated that premature deaths from cancer, however, would be reduced by only 7%, even if all the WHO targets are met. Deaths from cancer are expected to contribute almost 40% to overall NCD mortality by 2025.

***What makes cancer different from other NCD categories?***

One in six cancers is associated with a chronic infection. In the long-term, therefore, vaccination programmes (e.g. against hepatitis B) may help to further reduce the mortality rate for cancer. Among women over the age of 30, breast cancer represents 20% of all cancer diagnoses. The team of scientists predict that there will be no reduction in breast cancer mortality by 2025. This has been attributed, in part, to rising obesity levels among older women.

Among men, prostate cancer has the highest incidence of any cancer. Improvements to screening programmes

may help to reduce the mortality rate for this form of cancer.

References

http://www.who.int/nmh/ncd-tools/indicators-definition/en/

http://www.who.int/nmh/global_monitoring_framework/en/

Scientists have predicted that if the non-communicable disease (NCD) framework is put into practice, by 2025 the mortality rate for cardiovascular disease (CVD) is likely to be reduced to a greater extent than the mortality rate for cancer.

(i) Suggest **two** reasons why the CVD mortality rate is likely to be reduced to a greater extent than the cancer mortality rate.

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**[2]**

(ii) Scientists predict that reducing mortality from breast cancer will be difficult. Effective screening, however, can help reduce mortality rate.

Table 1.1 shows four techniques that are used to screen for breast cancer.

Complete Table 1.1 by:

- inserting the missing terms in column 1 and column 2
- inserting a tick (✓) or a cross (✗) as appropriate in column 3 and column 4 for each technique.

| Screening technique | Type of radiation detected | Produces three-dimensional image | Requires injection of radioactive substance |
|---|---|---|---|
| MRI scans | _____ | ✓ | ✗ |
| PET scans | _____ | | |
| _____ | Infrared radiation | | |

| | | | |
|---|---|---|---|
| CT scan | _____ | | |

Table 1.1

[4]

(iii) It is estimated that one in six cancers is associated with chronic bacterial or viral infections.

Suggest **one** way that chronic viral infections may cause cancer or increase the risk of developing cancer.

_____

_____

_____

_____

_____ [2]

(iv) Carcinogens can affect proto-oncogenes and tumour suppressor genes.

Outline the role of proto-oncogenes and tumour suppressor genes in cells.

proto-oncogenes _____

_____

tumour suppressor genes _____

_____

[2]

(b). Scientists have estimated that the mortality rate from CVD could be reduced by up to 34% by the year 2025 if the NCD framework proposed by the World Health Organisation (WHO) is implemented.

Coronary heart disease (CHD) is an example of a CVD.

(i) List **three** factors, other than diet and smoking, that may account for differences in CHD mortality rates between different regions of the world.

1

_____

2

3

[3]

(ii) The CHD mortality rate in the UK is decreasing.

CHD morbidity, however, has been rising in the UK and this has increased the financial burden of treating the disease. Diets that are high in fat and salt have been blamed for the increase in CHD morbidity.

Suggest **two** reasons why CHD mortality is decreasing in the UK even though CHD morbidity is increasing.

[2]

(c). Scientists predict three possible trends for the global reduction in NCD mortality by the year 2025. Fig. 1.1 shows these trends and the estimated reductions in NCD mortality.

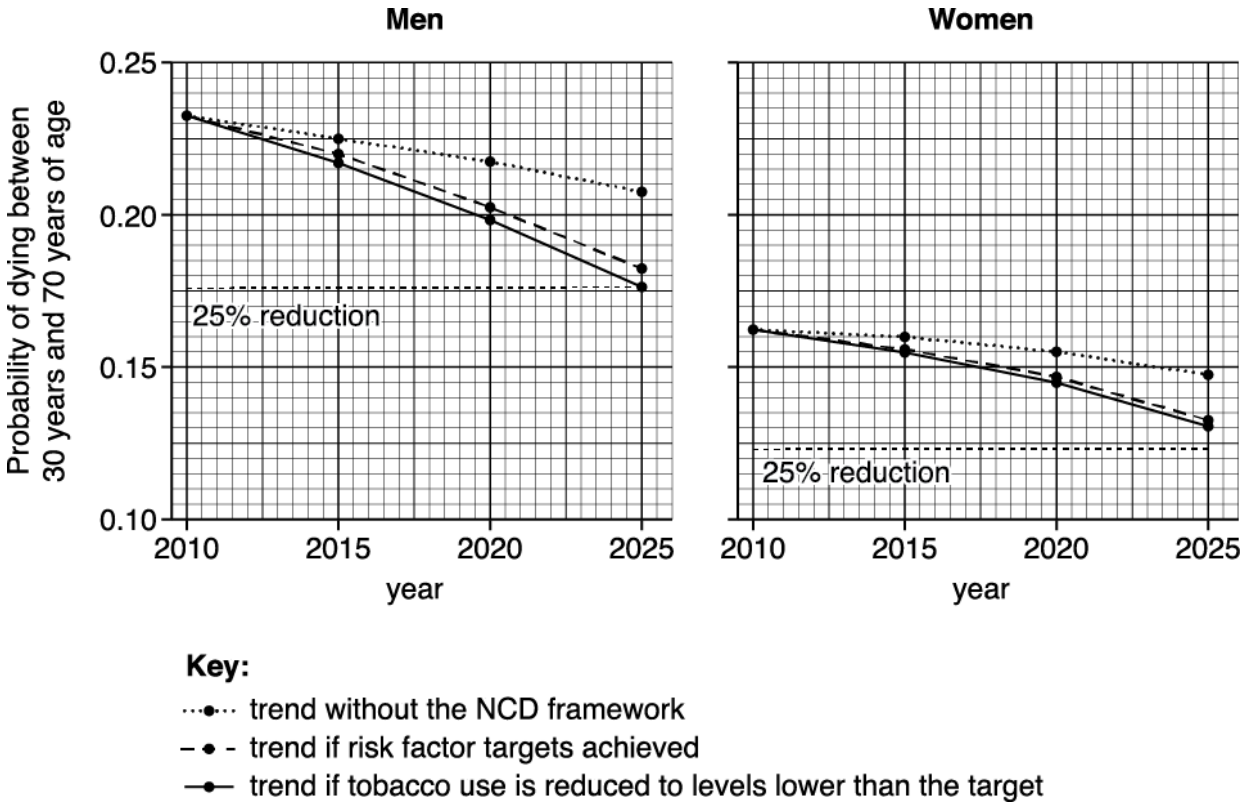


Fig. 1.1

Use the information in Fig. 1.1 to assess the likelihood of the World Health Organisation (WHO) achieving its target of a 25% reduction in NCD mortality by 2025.

[3]

5(a). The cell cycle is a regulated process.

Fig. 5 shows three checkpoints in the cell cycle where mistakes may be corrected.

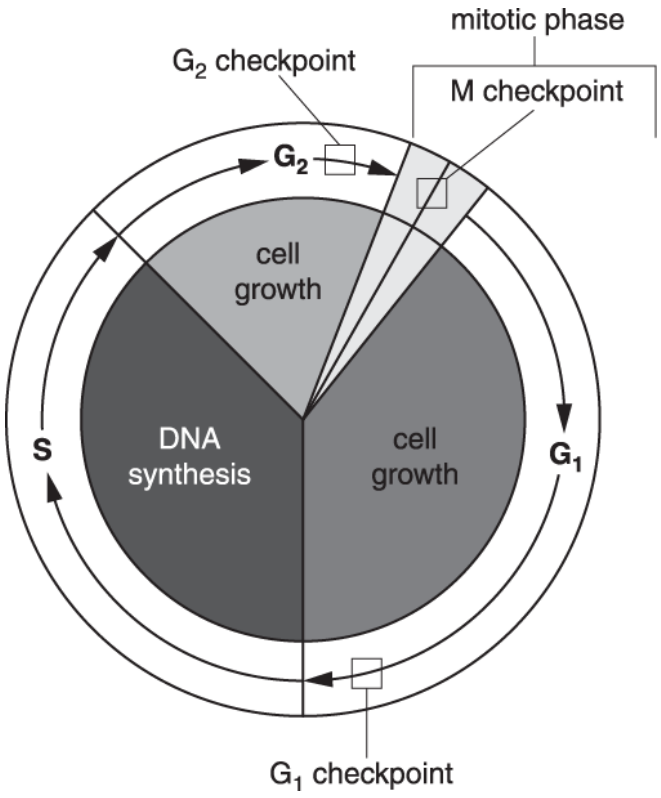


Fig. 5

Suggest how a faulty $G_2$ checkpoint may affect the cell cycle.

[2]

(b). It is thought that the *BRCA1* gene codes for a protein that is responsible for regulating the $G_2$ checkpoint.

Breast cancer may be caused by the inheritance of a faulty *BRCA1* gene.

What techniques can be used by radiographers in the detection of cancers such as breast cancer?

[3]

(c). * Some doctors think all babies should be tested for genetic conditions such as inherited forms of breast cancer.

Other doctors think the individual should have the right to decide whether they want genetic testing.

Discuss the ethical and economic considerations when screening for inherited forms of cancer.

[6]

6.

(i) Essential oils from plants can be used in aromatherapy as part of a treatment plan for cancer.

What is the term given to treatments such as aromatherapy?

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**[1]**

(ii) Evidence for the effectiveness of medical treatments is obtained from clinical trials.

Suggest **one** ethical issue that a medical practitioner might discuss with a patient who is requesting aromatherapy as a cancer treatment.

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**[1]**

7. Tobacco smoking is the cause of approximately 25% of all deaths from cancer in the UK and has killed millions of people over the last 50 years.

Table 3.1 shows the relative risk of lung cancer based on two variables:

- the number of years a person has smoked cigarettes
- the number of cigarettes smoked per day.

| Number of years smoking | Relative risk of lung cancer | | |
|---|---|---|---|
| | <10 cigarettes smoked | 10–19 cigarettes smoked | 20+ cigarettes smoked |
| <20 | 0.9 | 2.6 | 1.3 |
| 20–29 | 1.4 | 2.3 | 2.8 |
| 30–39 | 4.3 | 6.0 | 10.9 |
| 40–49 | 5.7 | 16.2 | 12.6 |
| 50+ | 17.6 | 22.6 | 41.0 |

Table 3.1

(i) Using the information in Table 3.1, calculate the percentage increase in relative risk of lung cancer when smoking 20+ cigarettes per day for 30–39 years compared to smoking fewer than 10 cigarettes per day for 30–39 years.

Show your working.

Answer = _____ %

**[2]**

(ii) Suggest an explanation for the trends shown in Table 3.1.

_____

_____

_____

_____

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---[3]

(iii) A student examining the data in Table 3.1 made the following statement:

"*The number of cigarettes you smoke per day doesn't affect your risk of developing lung cancer*."

Suggest one piece of evidence that supports the statement **and** one piece of evidence that does not support the statement.

*evidence supporting the statement*

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*evidence not supporting the statement*

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---[2]

8(a). Cancer may develop as a result of mutations in stem cells.

Describe how a mutation of a proto-oncogene in a stem cell may give rise to cancer.

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---[3]

(b). Apoptosis is the process that destroys cancerous cells, but it is also essential in the normal development of an embryo.

(i) Define *apoptosis*.

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---[1]

(ii) Give **one** example of apoptosis in the normal development of an embryo.

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---[1]

9. This question is based on the case study '**INTERVIEW WITH A PHLEBOTOMIST' (Case Study 1).**

You were told in the case study that blood samples can be tested for the presence of tumour markers. High levels of tumour markers may indicate that a person has cancer.

(i) Explain what is meant by cancer.

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---[1]

(ii) What type of proteins could be used to confirm the presence of tumour markers in a blood sample?

---[1]

10. The prevalence of bowel cancer has increased in the UK over the last 40 years.

Benzopyrene is a molecule that has been linked to an increased risk of bowel cancer. It can be produced in cigarette smoke and burned food. Research indicates that benzopyrene may affect the p53 gene.

(i) Define the term *prevalence.*

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[1]

(ii) Suggest how benzopyrene may affect the p53 gene, leading to an increased risk of cancer.

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[3]

(iii) Benzopyrene is a chemical carcinogen. Exposure to chemical carcinogens increases the risk of developing cancer.

State **two** other factors that increase the risk of developing cancer.

1

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2

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[2]

(iv) Some forms of cancer are described as acute.

State what is meant by *acute.*

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[1]

11.

Neuropathic pain is a type of pain caused by neurones malfunctioning following nerve damage. When this happens, some voltage-gated sodium ion channels (VGSCs) in pain receptors open spontaneously.

(i) Single nucleotide polymorphisms (SNPs) have been detected in the genes coding for several types of VGSC. It is thought that these SNPs might alter the response of different patients to drugs that block VGSCs.

Describe the steps involved in identifying the SNPs present in a DNA sample from a patient.

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[2]

(ii) Screening for other SNPs is used in the study, diagnosis, and treatment of cancer.

A mutation in either the *BRCA1* or *BRCA2* gene increases the risk of breast cancer.

Explain why screening for these mutations is only offered to individuals with a strong family history of breast cancer and a living relative with breast cancer.

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[2]

12.

Hereditary non-polyposis colorectal cancer (HNPCC) is a type of bowel cancer caused by a mutation in genes that normally repair DNA.

Explain why mutations in DNA repair genes lead to development of cancer in the bowel and other organs.

[3]

13(a). Researchers were studying the possible association between smoking and the respiratory tract infections, pneumonia and bronchitis.

The study included an analysis of the infection figures for **all** admissions to a hospital.

- Data from 5018 patients were collected.
- 4022 of these patients were **non-smokers**.
- Each patient had only **one** infection.

Some of the data from this study are shown in Table 5.1.

| | Number of patients admitted with a respiratory tract infection | | Number of patients admitted with other type of infection |
|---|---|---|---|
| | Pneumonia | Bronchitis | |
| Smokers | 335 | 230 | 431 |
| Non-smokers | 1166 | 526 | 2330 |

**Table 5.1**

Calculate the percentage of patients who were **smokers**.

Give your answer to **two** decimal places.

_____ % **[2]**

(b). The researchers stated the following null hypothesis:

Smoking does not affect the incidence of respiratory tract infections.

(i) Analyse the data in this study **and** comment on the researchers' hypothesis.

In your answer you should use data to support your analysis.

[3]

(ii) Suggest **one** statistical test that could be used to analyse the data further.

[1]

(iii) Why would this statistical test be the most useful?

[1]

14(a). Tobacco smoke is a carcinogen. It can damage the DNA of the cells lining the trachea resulting in the development of a tumour.

Explain how damage to DNA can result in the development of a tumour.

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[2]

(b). Research was carried out into the effect of smoking on the incidence of lung cancer.

Fig. 1.2 shows the results of this research.

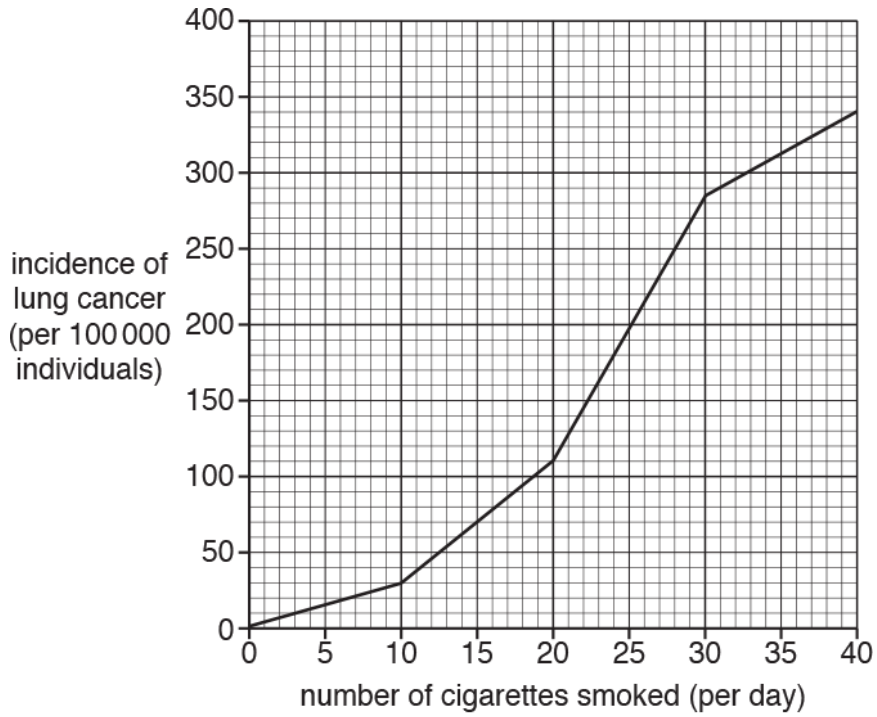


Fig. 1.2

(i) State **two** factors that should have been considered when selecting people to participate in this research.

Factor 1

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Factor 2

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[2]

(ii) Using Fig. 1.2, calculate the percentage increase in the incidence of lung cancer when the number of cigarettes smoked increases from 20 to 40 per day.

Give your answer to the **nearest whole number**.

Answer = _____ % **[2]**

(c).

(i) Lung cancer can be detected using a technique called endoscopic ultrasound.

When using this technique, instead of placing the ultrasound probe on the outside of the chest, it is inserted through the mouth and into the airways of the lungs.

Suggest why endoscopic ultrasound is used rather than standard ultrasound for detecting lung cancer.

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[1]

(ii) The number of people alive ten years after being diagnosed with a disease is called the ten year survival rate.

Lung cancer has one of the lowest ten year survival rates of all common cancers.

Suggest why the ten year survival rate for lung cancer is low.

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[2]

(d). Trastuzumad is an immunotherapy drug used in the treatment of breast cancer, but it has proved ineffective in treating lung cancer.

Using your knowledge of how **immunotherapy** drugs work, explain why trastuzumad can be used to treat breast cancer but **not** to treat lung cancer.

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[1]

(e). During chemotherapy treatment, the majority of body cells are not affected by the drugs used.

However, some cells, such as those in hair follicles and bone marrow, may be damaged by chemotherapy drugs.

Explain why.

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[1]

END OF QUESTION PAPER

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 1 | | i | Any 3 from:<br>amino acid sequence gives complementary shape to antigen (1)<br>variable region specific to antigen on cancer cells (1)<br>chemotherapeutic agent attached to antibody (1)*<br>(Antibody Drug Conjugate) floats in the bloodstream sticking only to cancer cells (1)<br>once attached, the agent kills the cancer cell (1)<br><br>direct attachment of antibodies to cancer cells (1)<br>(monoclonal antibody) marks cancer cell for destruction (1)<br>antibodies attach to T cells to stimulate them to attack cancer cells (by keeping them switched on) (1) | 3 | *ALLOW toxin / drug is attached to the antibody |
| | | ii | Any 2 from:<br>may encourage unprotected sex (1)<br>requires parental consent (1)<br>does not consider the child's point of view (1)<br>vaccines can have side effects (1) | 2 | |
| | | | Total | 5 | |
| 2 | | i | 44% (1) (1) | 2 | 1 mark for calculation. 500 – 280 × 100 / 500 |
| | | ii | Any 3 from:<br>decrease in risk with ageing from 0–9 years (1)<br>remains steady / age has little effect, from 10–29 years (1)<br>increase in risk with ageing from 30–74 years (1)<br>decrease in risk with ageing from 75–85 years in males (1)<br>after 35 years risk for males increases more than females (1)<br>age 85+ risk is greater for females (1) | 3 | |
| | | | Total | 5 | |
| 3 | | i | (Allergy to) pollen (1) | 1 | |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | ii | *idea that* more asthma attacks in young people in late summer / autumn (1)<br>*idea that* main trigger in young people is fungal spores (1)<br>*idea that* asthma in adults higher in winter and spring (1)<br>due to (more) infections (winter) or pollen (spring) (1)<br>ref other allergens / named allergens not being seasonal (1) | 3 | ALLOW references to dust mites |
| | | ii | Manipulation of data in support of any point (1) | 1 | |
| | | | Total | 5 | |

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>4</td><td>a</td><td>i</td><td>less genetic influence in CVD;<br>idea of (named) risk factors / lifestyle choices, controlled(for CVD);<br>more easily treated;<br>idea of cancer incidence being more random than CVD cases;</td><td>2 max</td><td>ACCEPT ora throughout<br><br>Examiner's Comments<br><br>This question related to Case Study: 25 by 25. This question was answered well although some candidates would have benefited from a more extensive scrutiny of the pre-release material as they failed to grasp some of the contextual data in this question.<br><br>Many candidates were able to gain at least one mark by suggesting either that CVD is easier to treat or that it can be controlled by changing life style. Some candidates stressed smoking in the context of causing CVD without appearing to appreciate that this would also be a leading cause of certain cancers. Thus for a comparative answer, candidates should have concentrated on life style changes that would have a greater influence on CVD mortality reduction. Some candidates felt that cancer could not be treated or that death from cancer was inevitable. Candidates who mentioned genetics felt that cancer had a genetic predisposition but did not appreciate that this also applies to CVD. Thus the mark point for genetic influence was designed to illustrate this in a comparative manner and clarify the greater genetic influence for cancer mortality.</td></tr>
<tr><td></td><td></td><td>ii</td><td><table><tr><th>Screening technique</th><th>Type of radiation detected?</th><th>Produces three-dimensional image</th><th>Requires injection of radioactive substance</th></tr><tr><td>MRI scans</td><td>Radio waves</td><td>✓</td><td>x</td></tr><tr><td>PET scans</td><td>Gamma (rays)</td><td>x</td><td>✓</td></tr><tr><td>Thermography</td><td>Infrared radiation</td><td>x</td><td>x</td></tr><tr><td>CT scan</td><td>X-rays</td><td>✓</td><td>x</td></tr></table></td><td>4</td><td>One mark per correct row<br>IGNORE (electro) magnetic or ionising radiation<br><br>Examiner's Comments<br><br>Thermography and CT-scan mark points were well answered. ‘Radio waves’ was rarely seen as the correct response for the type of radiation for MRI scans with a significant number of candidates generalising with magnetic or ionising radiation.</td></tr>
</table>

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | iii | *idea that* chronic viral infection may weaken immune system / virus goes undetected by immune system;<br>(viruses) insert, genetic material / DNA, into cell's, genome / DNA / chromosomes;<br>(virus causes) <u>mutation</u> of host (proto-oncogenes or tumour suppressor) genes / DNA;<br>*idea that* virus, activates / contains, oncogenes;<br>*idea that* virus inhibits, tumour suppressor / *p53*, gene; | 2 max | <u>Examiner's Comments</u><br><br>All mark points were seen in response to this question and it was pleasing to see a number of candidates correctly referring to mutations in proto-oncogenes or tumour suppressor genes. Many candidates correctly stated the insertion of viral DNA but merely stated insertion into a cell, not following through with the genetic material of the cell. |
| | | iv | *proto-oncogenes*:<br>*idea that* controls cell division by coding for, groth factor / growth factor receptor / cyclins / CDKs;<br>*tumour suppressor genes*:<br>*idea of* prevents, damaged cells / cells with damaged DNA, dividing; | 2 | ACCEPT apoptosis of damaged cells/cells with damaged DNA<br><br><u>Examiner's Comments</u><br><br>Candidates struggled to fulfil the layers required for the mark points although many candidates offered correct part-answers e.g. referred to proto-oncogenes as controlling cell division but did not extend to include that this was done by coding for growth factors. The role of tumour suppressor genes was clearly linked to apoptosis by most candidates although some failed to say this would occur to a <u>damaged</u> cell. |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | b | i | exercise;<br>genetics;<br>age of population;<br>obesity;<br>blood pressure; | 3 max | IGNORE reference to health care provision / education<br>IGNORE ethnicity<br>IGNORE age unqualified<br><br>Examiner's Comments<br><br>This was well-answered by most candidates. Some candidates still proffered diet-related answers e.g. reduce salt intake, even though the question stated 'other than diet'. There were many answers referring to health care provision prompted by the reference in the question to different regions of the world, however this was not credit worthy as the answers centred around the NCD framework which the pre-release material stated. |
| | | ii | *idea of* improved, screening / diagnosis / medical advice;<br>*idea of* improved, medication / treatment / surgical techniques; | 2 | ACCEPT named example<br><br>Examiner's Comments<br><br>Candidates made clear reference to an improved system, usually of treatment rather than diagnosis. The majority of answers continued to discuss reasons why morbidity was increasing. |
| | c | | (25 %) reduction will not be achieved for, women / men, even if risk factor targets met;<br>(25 %) reduction can be achieved for men if tobacco use is reduced to levels lower than the target;<br>(25%) reduction cannot be achieved for women if tobacco use is reduced lower than the target;<br>correct use of probability figures at 2025 to support argument<br>(foreither gender); | 3 max | Examiner's Comments<br><br>The majority of candidates were able to access the first three mark points to gain credit, but Examiners rarely saw candidates correctly using probability figures from the graphs. Some candidates did not understand the significance of the year 2025 when answering the question and thought that the targets would be met for both men and women as all trends showed a decrease. |
| | | | Total | 18 | |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 5 | a | | no response to / detection of, DNA damage / AW ✓<br>cells division / mitosis, continues ✓<br>apoptosis not triggered ✓ | 2 Max | ACCEPT DNA replication not checked<br><br>Examiner's Comments<br><br>Some candidates had clearly not read the question properly and wrote about what the G2 checkpoint does in general and didn't go as far as thinking about what would happen if it was faulty. |
| | b | | X–ray / mammogram / CT / computerized tomography ✓<br>MRI scan ✓<br>PET scan ✓<br>thermography ✓<br>ultrasound / sonography ✓ | 3 Max | IGNORE screening programmes<br><br>Examiner's Comments<br><br>Almost all candidates could state at least one imaging technique and many candidates got three. |
| | c | | **Please refer to the marking instructions for guidance on how to mark this question.*<br><br>*In summary:*<br>*Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)*<br>*Using a 'best-fit' approach based on the science content of the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.*<br>*Then, award the higher or lower mark, according to the communication statement (in italics).*<br><br>• *The science content determines the level.*<br>• *The communication statement determines the mark within a level.*<br><br>Level 3 (5–6 marks)<br>Provides a comprehensive explanation of both the ethical and economic considerations when screening.<br>*There is a well–developed line of reasoning which is clear and logically structured and flows. All the information presented is relevant.* | 6 | scientific points may include<br><br>Ethical<br><br>• rights of babies<br>• may give false result<br>• religious / cultural reasons<br>• may cause an immune response in patient<br>• telling someone they may develop a disease which might never happen<br>• consequences of results to families<br>• discrimination qualified e.g. insurance, employment<br><br>Economic<br><br>• expensive to test all babies<br>• other services would have to be cut / money would have to found from |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | | **Level 2 (3–4 marks)**<br>Provides a partial explanation of both the ethical and economic considerations when screening.<br>*There is a line of reasoning presented with some structure. The information presented is mostly relevant.*<br><br>**Level 1 (1–2 marks)**<br>Provides an explanation of either the ethical and economic considerations when screening.<br>*The information is communicated with little structure. The answer does not flow and detracts from communicating the information.*<br><br>**0 marks**<br>No response or no response worthy of credit. | | elsewhere<br>• unnecessary cost as most babies don't carry the gene<br>• money could be better spent<br>• money could be invested in treatments / research<br><br>Examiner's Comments<br><br>The most common level achieved in (c) was two or three with only a few candidates scoring five or six marks. This was often due to the fact that candidates wrote a lot about ethics and very little about economics. The most common, and often only, economic statement was that it would be expensive to test all babies. A few candidates wrote about the ethical issues with abortions which were not relevant when the question was about screening babies. |
| | | | Total | 11 | |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 6 | | i | complementary (therapy); | 1 | ACCEPT 'alternative medicine, holistic (treatment)<br><br>Examiner's Comments<br><br>This question was based on the pre-release material, and tested a range of abilities.<br>Candidates achieved higher marks if they had thoroughly researched the material provided. This question assessed AO1, AO2 and AO3 skills.<br><br>This was generally well answered. Some candidates confused aromatherapy with chemotherapy or immunotherapy. |
| | | ii | *idea that* aromatherapy alone will not work (to treat cancer);<br><br>*idea that* might negatively affect prescribed treatment;<br><br>*idea that* conventional treatment / medicine might be, refused / given up; | 1 | IGNORE gives false hope<br><br>Examiner's Comments<br><br>This question was based on the pre-release material, and tested a range of abilities.<br>Candidates achieved higher marks if they had thoroughly researched the material provided. This question assessed AO1, AO2 and AO3 skills.<br><br>A common mistake was to state that this treatment would not work as well against cancer, rather than it wouldn't work at all. Comments such as 'these give false hope' were not credited. Candidates mistakenly think that plants are 'harvested' to obtain medicine so endangering plant species. |
| | | | Total | 2 | |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 7 | | i | 153 / 153.49 / 153.5 (%);; | 2 | 2 marks for correct answer<br>If answer incorrect, award 1 mark for correct working<br><br>i.e. $\frac{10.9 - 4.3}{(?)} \times 100$<br>Where (?) = 10.9 or 4.3<br><br>**Examiner's Comments**<br><br>This question equally addressed **AO1** and **AO2**, and had some elements of **AO3**.<br><br>Very few candidates knew how to correctly calculate % increase. Some candidates could correctly work out the difference in risk, but then often divided by the incorrect denominator. |
| | | ii | *Idea of*<br>(people who have smoked, more cigarettes / for longer have) more exposure to (named) carcinogens (in tobacco smoke);<br>(the more a person smokes) the more likely they are to have a mutation;<br><br>increase in (number of) mutations increases the risk of cancer;<br><br>lung cancer takes a long time to develop; | 3 | **IGNORE** 'chronic' disease without qualification<br><br>**Examiner's Comments**<br><br>This question equally addressed **AO1** and **AO2**, and had some elements of **AO3**.<br><br>Candidates who focussed on the command word 'explain' in the question scored well in this question, explaining how increased smoking led to more exposure to carcinogens, leading to the increased mutation risk. Some candidates just gave a description of the trend which failed to gain credit. |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | iii | *supports*<br><br>In the less than 20 years of smoking group, there is a higher (relative)<br><br>risk (of lung cancer) if 10-19 cigarettes are smoked<br><br>than if 20+ are smoked;<br><br>In the 40-49 years of smoking group, the (relative) risk (of lung cancer)<br><br>when smoking 20+ is less than the risk when smoking 10-19<br><br>cigarettes;<br>*does not support*<br>*Idea that* 20 –29 / 30 – 39 / 50+ years of smoking, the higher the number of cigarettes smoked per day the higher the risk of lung cancer; | 2 | **Number of years smoking** / **Relative risk of lung cancer**: <10 cigarettes smoked; 10-19 cigarettes smoked; 20+ cigarettes smoked<br><20: 0.9; 2.6; 1.3<br>20-29: 1.4; 2.3; 2.8<br>30-39: 4.3; 6.0; 10.9<br>40-49: 5.7; 16.2; 12.6<br>50+: 17.6; 22.6; 41.0<br><br>**Examiner's Comments**<br><br>This question equally addressed **AO1** and **AO2**, and had some elements of **AO3**.<br><br>Candidates who carefully considered the data and its meaning often scored both marks, recognising that the data for those smoking less than 20 years, or for 40 - 49 years, did not support the statement, whereas the data for those who smoked for 50+ years (for example) did. |
| | | | Total | 7 | |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 8 | a | | (a mutation) causes it to become an oncogene;<br><br>(proto-oncogene) may code for / AW, (named) proteins involved in, the control of cell, division / cycle;<br><br>(if mutated) correct (named) protein, no longer produced / overproduced;<br><br>(if mutated) receptor protein triggers cell division in absence of growth factor / AW; | 3 | named protein examples - receptor proteins / growth factors / cyclins / transcription factors<br><br>ACCEPT mutation results in uncontrolled cell division or uncontrolled mitosis.<br><br>Examiner's Comments<br><br>Similar numbers of AO1 and AO2 marks were available in this question.<br><br>Candidates often confused proto-oncogenes with tumour suppressor genes. An example of a proto-oncogene is the Ras proto-oncogene, which is quite different from the tumour suppressor gene p53. Most candidates gained marks for identifying the consequence of uncontrolled cell division. The best candidates could describe the role of a proto-oncogene in control of the cell cycle and how that changes when it mutates to an oncogene. |
| | b | i | controlled / programmed, cell death / AW; | 1 | IGNORE cell suicide unqualified<br><br>Examiner's Comments<br><br>Similar numbers of AO1 and AO2 marks were available in this question.<br><br>Most candidates gave the correct answer of programmed cell death. Some candidates failed to score because they did not indicate that the cell death was controlled or triggered, or used the term ‘cell suicide’ which is not appropriate scientific language at GCE level. |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | ii | *Examples include but are not limited to*<br>finger / toe, separation / AW;<br>formation of synapses; | 1 | Examiner's Comments<br><br>Similar numbers of AO1 and AO2 marks were available in this question.<br><br>This question was well answered by the majority of candidates. A minority of candidates talked about removing damaged cells, or menstruation which is not appropriate as the question is in the context of a foetus. |
| | | | Total | 5 | |
| 9 | | i | uncontrolled, cell division / mitosis; | 1 | ACCEPT uncontrolled cell cycle / mass of abnormal cells / malignant tumour<br>IGNORE growth<br><br>Examiner's Comments<br><br>This question was based on the pre-release material, and tested a range of abilities. Candidates achieved higher marks if they had thoroughly researched the material provided. This question assessed mostly A01, AO2 and AO3 skills.<br><br>Most candidates correctly explained what is meant by cancer. Those who did not usually referred to 'growth' of cells and not division. Some candidates discussed cell/DNA mutations without further clarification. |
| | | ii | antibody / antibodies (for antigen markers); | 1 | IGNORE glycoproteins<br><br>Examiner's Comments<br><br>Many candidates incorrectly named glycoproteins. Few correctly named antibodies. |
| | | | Total | 2 | |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 10 | | i | number of (existing) cases of a disease (in a population); | 1 | DO NOT CREDIT reference to new cases<br><br>Examiner's Comments<br><br>This question addressed AO1, AO2 and AO3 skills.<br><br>Most candidates correctly defined the term 'prevalence'. A few candidates incorrectly answered in terms of new cases or an increase in cases. |
| | | ii | p53 (gene) is a tumour suppressor gene;<br><br>(benzopyrene causes) mutation (of p53 gene);<br><br>cell cycle not halted / no detection of DNA damage / AW;<br><br>no apoptosis (of cells with, damaged/mutated, DNA); | 3 max | ACCEPT correct detail of p53 pathway (e.g. P53 (gene) not expressed, p53 (protein) no longer produced / p53 protein cannot bind to DNA / p21(gene) not expressed, P21 no longer produced / CDKs continue to be activated<br><br>Examiner's Comments<br><br>Most candidates correctly identified that benzopyrene caused a mutation in p53 gene, although some merely wrote about p53 being inactivated or not working. A number of candidates were able to give further detail of the consequences of the mutation, although some failed to discriminate between the gene and the protein, stating that genes will not be produced. Several candidates wrote that p53 is a proto-oncogene rather than a tumour suppressor gene. Few candidates discussed the lack of apoptosis. |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | iii | heredity / genetic predisposition / family history (of cancer);<br><br>viruses / viral infection;<br><br>age / ageing;<br><br>(exposure to ionising) radiation;<br><br>lack of exercise / being overweight; | 2 max | **Mark the first answer** on each line. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**<br><br>**IGNORE** references to diet/smoking / alcohol as these factors involve chemical carcinogens.<br><br>**ACCEPT** genetics<br><br>**CREDIT** weakened immune system / AW<br><br>**CREDIT** UV, x-ray, gamma rays<br>**DO NOT CREDIT** radio waves, infrared, microwaves<br><br>**CREDIT** HRT<br><br>**Examiner's Comments**<br><br>This was a well answered question. Some candidates referred to chemical carcinogens, e.g. diet or smoking, indicating that they did not read the question properly. |
| | | iv | rapid onset and short-lived / lasts short time; | 1 | **Examiner's Comments**<br><br>Very few candidates were able to give the correct definition as rapid onset and short-lived. Most were able to give only part of the definition. Many talked of it being 'small' or 'non-invasive' or 'curable' or 'in the early stages'. |
| | | | **Total** | 7 | |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 11 | | i | DNA, cut / fragmented, using, restriction enzymes / endonucleases ✓<br><br>separate fragments using gel electrophoresis ✓<br><br>sequence fragments / add labelled probe ✓<br><br>compare to database / DNA samples from other individuals ✓ | 2 max | ACCEPT any valid method of labelling<br><br>Examiner's Comments<br>Candidates struggled with **(c)(i)** and could not discuss it in sufficient detail. Many candidates discussed electrophoresis separating the SNPs, not appreciating that it separates on the basis of size and a probe would need to be used to pick up individual SNPs. Indeed some candidates stated that the DNA ladder would identify the SNPs and did not seem to realise that a DNA ladder is also based on size only. Many candidates spoke about PCR being used to amplify the sample thus not realising that this would not be necessary as enough DNA would be available to proceed without performing PCR. |
| | | ii | greater risk of, developing breast cancer / having mutated gene, if have family history ✓<br><br>high cost means screening must be restricted ✓<br><br>living relative needed to identify faulty gene ✓<br><br>(this gene) tested for in the individual / predictive testing ✓ | 2 max | Examiner's Comments<br>For **(c)(ii)** most candidates achieved mp2 with a good understanding of the financial cost of testing everyone. Some candidates felt that the emotional impact of testing everyone should be considered and a few discussed the testing in terms of causing harm to the patient. Thus some candidates had not connected this question with the previous question of taking a blood sample and were visualising this method as a radioactive procedure. Many candidates wrote about the increased chance of inheriting the gene without realising that it is the mutated gene that is relevant, as everyone inherits these genes. The importance of the BRCA genes should not be restricted to their mutated forms and breast cancer. |
| | | | Total | 4 | |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 12 | | | Mutation / fault / damage, in <u>DNA</u> is not removed ✓<br><br>(this) increases (general) mutation rate / accumulation of DNA damage ✓<br><br>(increased) mutation in proto-oncogenes / tumour suppressor genes ✓<br><br>apoptosis, is not triggered / does not occur ✓<br><br>(leads to) uncontrolled, mitosis / cell division ✓ | 3 max | Look for linking of faulty DNA repair mechanisms with increase in mutation rate.<br><br>Examiner's Comments<br>For (c) most candidates achieved mp5 as a clear description of cancer development. Many candidates discussed this in terms of mutations in tumour suppressor genes or proto-oncogenes. |
| | | | Total | 3 | |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 13 | a | | 19.85 ✓✓ | B | ALLOW maximum of one mark for 19.849 OR 19.8 (incorrect number of decimal places)<br><br>DO NOT ALLOW 19.9 (incorrect rounding)<br><br>If answer is incorrect or missing ALLOW maximum of one mark for correct working<br>$\frac{996}{5018} \times 100$<br>Examiner's Comments<br>Q5(a) was a straightforward calculation and the majority of candidates gained the mark here. Some however did not quote their answer to the correct number of decimal places and/or had rounding errors. |
| | b | i | *Analysis of data*<br>more cases of respiratory tract infections among smokers than expected<br>OR<br>pneumonia is more common than bronchitis among both smokers and non-smokers<br>OR<br>smoking appears to significantly increase the risk of bronchitis and may also (slightly) increase the risk of getting pneumonia ✓ | 3 | ALLOW more cases of pneumonia and bronchitis among smokers than expected |
| | | | supporting data referring to expected number of cases ✓ | | e.g. expected cases of pneumonia among smokers<br>297.95 or 298<br>OR<br>expected cases of bronchitis among smokers 150.07 or 150<br>OR<br>e.g. expected cases of pneumonia among non-smokers<br>1203.05 or 1203<br>OR<br>expected cases of bronchitis among non-smokers<br>605.93 or 606 |
| | | | supporting data referring to % of cases ✓ | | 23.09% or 23.1% or 23% of smokers had bronchitis compared with 13.08 or 13.1% or 13% of non-smokers |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | | | | OR<br>about 33.63% or 33.6% or 34% of smokers had pneumonia compared to 28.99% or 29.0% or 29% of non-smokers |
| | | | *Comment on hypothesis*<br>null hypothesis should be rejected ✓ | | ALLOW hypothesis is not supported<br>IGNORE hypothesis is, false / wrong / contradicted<br><br>**Examiner's Comments**<br>**Q5(b)(i)** proved to be a challenging question as candidates were not confident in selecting the appropriate data to anlayse. Candidates were expected to calculate the % of smokers and % of non-smokers in the study and use these percentages to then determine whether the actual observed numbers/% were in-line with, or different from, the expected values. Again errors were seen with candidates referring to the null hypothesis being wrong/invalid/disproved/incorrect rather than rejected/not supported. |
| | | ii | chi-squared ✓ | 1 | ALLOW $\chi^2$ test<br><br>**Examiner's Comments**<br>Few candidates gained the mark for **Q5(b)(ii)** with the most common answer incorrectly being a *t*-test. Candidates did not appreciate the need to test whether the observed values were significantly different from the expected values. |
| | | iii | (chi-squared test) tests the significance of the difference between, observed and expected results ☐ | 1 | **Examiner's Comments**<br>Candidates who gave the incorrect answer to **Q5(b)(ii)** were unable to gain the mark for **Q5(b)(iii)** and often did not give the appropriate reason as to why the test would be appropriate. |
| | | | Total | 7 | |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 14 | a | | mutation / described ✓<br>proto-oncogenes become oncogenes ✓<br>(causes) uncontrolled, mitosis / cell division / cell replication ✓<br><br>idea that damages p53 gene ✓<br>idea that mutation / damage, could be in tumour suppressor gene ✓ | Max 2 | Examiner' Comments<br>The mutation mark was often awarded for **(b)** but very few made the link to proto-oncogenes or tumour suppressor genes. |
| | b | i | ANY TWO FROM<br><br>gender ✓<br>age range ✓<br>how long they have smoked for ✓<br>underlying medical condition ✓<br>family history of lung cancer ✓ | Max 2 | IGNORE number of cigarettes smoked per day<br>Examiner' Comments<br>**(c)(i)** was usually well answered with age and gender being the most common given. |
| | | ii | 209 (%)✓✓ | 2 | If answer not given to nearest whole number allow 1 mark for correct working ..<br>340-110<br>OR<br>divided110<br>OR<br>209.1 or 209.09<br>Examiner' Comments<br>Many candidates calculated 110/340 instead of (340–110)/110 for **(c)(ii)**. |
| | c | i | *idea that* clearer image can be gained without interference from the rib cage ✓ | 1 | Examiner' Comments<br>In **(d)(i)** 'more accurate' was often given. Very few candidates made the link between ultrasound and ribs. |
| | | ii | *idea that* no symptoms / symptoms similar to minor illness ✓<br>rarely diagnosed early ✓<br>difficult to treat / lumpectomy often not possible ✓<br>no routine screening for lung cancer ✓ | Max 2 | Examiner' Comments<br>It was common in **(d)(ii)** to see 'vital organ' and an explanation of the importance of the role of the lungs in respiration and therefore to life. Some candidates got 'hard to treat' but very few got the idea that it is rarely diagnosed early. |
| | d | | *idea that* receptors / antigens, for the drug are not found on the cell surface membrane of lung cancer cells ✓ | 1 | ALLOW ORA for breast cancer cells<br>Examiner' Comments<br>In **(e)** candidates often stated 'specific' but rarely made the link to antigens. |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | e | | *idea* that cells undergo cell division regularly ✓ | 1 | Examiner' Comments<br>Candidates generally had the right idea about rapidly dividing cells for **(f)** but few candidates were unable to achieve the mark for referring to rapidly 'growing' cells. |
| | | | Total | 11 | |