

Surname	Centre Number	Candidate Number
Other Names		2



**GCE AS/A level**

1661/01



S16-1661-01

**APPLIED SCIENCE  
UNIT 1**

P.M. WEDNESDAY, 18 May 2016

1 hour 30 minutes

For Examiner's use only			
	Question	Maximum Mark	Mark Awarded
Section A	1-9.	29	
Section B	10.	15	
	11.	11	
	12.	11	
	13.	14	
	<b>Total</b>	<b>80</b>	

**ADDITIONAL MATERIALS**

In addition to this examination paper, you will need a calculator.

**INSTRUCTIONS TO CANDIDATES**

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

**INFORMATION FOR CANDIDATES**

Section A is based on the pre-release article (included).

The number of marks is given in brackets at the end of each question or part-question.

You are reminded that assessment will take into account the quality of written communication used in your answers.

A data sheet can be found on page 28.

## **‘I didn’t fit the typical profile of someone with lung cancer’ Lung cancer: Iwan’s story**

Iwan was diagnosed with lung cancer after visiting his GP with pain and swelling in his knees. “My symptoms were quite unusual for lung cancer. It began with a swelling on my knees, so I went to my GP who X-rayed them. There was nothing structurally wrong, so he gave me some anti-inflammatory drugs. It didn’t seem to improve the situation. I have two small children, so I’m up and down on my knees quite a bit, and it was becoming quite painful. I went to see a rheumatologist, who gave me a complete examination and checked my knees and my fingers. She noticed that my hands had finger clubbing, which is a swelling of the ends of the fingers.”

“As a precaution, she ordered a chest X-ray, because this condition could be a sign of chest problems, such as bronchitis. Fifteen minutes later she came back with the X-ray, which showed I had a huge shadow on my right lung. I was referred to a chest physician, who did some further tests. Those confirmed I had a syndrome called hyper pulmonary osteoarthritis (HPOA), where the lining of the bones becomes thick. It’s often associated with non-small-cell lung cancer.”

“Lung cancer is statistically associated with smoking, and 80% of cases are linked with smoking. I smoked 15 years ago but I hadn’t smoked for many years because of the children. I didn’t fit the typical profile of a lung cancer sufferer who smokes 20-40 cigarettes a day.”

“In the right lung you have three lobes. Surgeons cut a hole in my back and removed one of the lobes and basically joined it back together. They probably removed about a third of my right lung. But about four weeks after surgery, I was feeling better. I didn’t have any major side effects from chemotherapy, so I was quite fit and active. But radiotherapy made my oesophagus very inflamed and it was incredibly painful for me to swallow.”

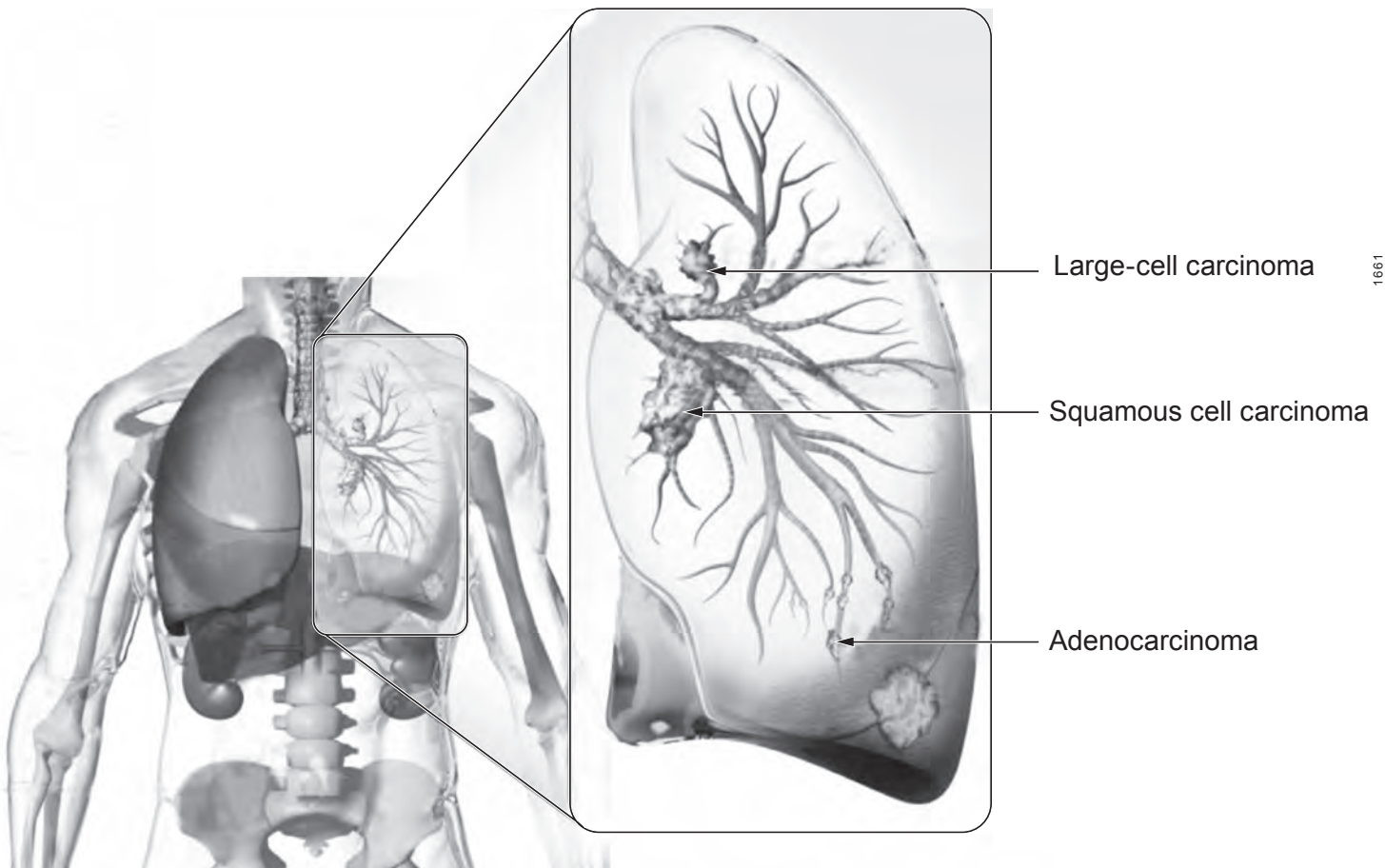
“One of the things that I found most helpful was the cancer nurse specialists. They were excellent at being sympathetic, answering questions and giving advice. I would suggest that anyone going through the same thing should use all of the available resources and try to find something positive to focus on.”

## 30 1. Introduction

Lung cancer is one of the most common and serious types of cancer. Over 41 000 people are diagnosed with the condition every year in the UK. There are usually no signs or symptoms in the early stages of lung cancer, but many people with the condition will eventually develop symptoms such as persistent cough, persistent breathlessness, persistent tiredness, weight loss and pain when breathing or coughing.

Cancer that begins in the lungs is called primary lung cancer. There are two main types of primary lung cancer. These are classified by the type of cells in which the cancer starts. They are:

- 40 • **small-cell lung cancer** – the least common type that usually spreads faster than non-small-cell lung cancer
- **non-small-cell lung cancer** – the most common type, accounting for more than 80% of cases; can be either squamous cell carcinoma, adenocarcinoma or large-cell carcinoma



**Figure 1 Areas affected by cancerous cells**

45 Lung cancer mainly affects older people. It is rare in people younger than 40, but the rates of lung cancer rise sharply with age. Lung cancer is most commonly diagnosed in people aged 70-74 years. Although people who have never smoked can develop lung cancer, smoking is the main cause (about 90% of cases). This is because smoking involves regularly inhaling a number of different toxic substances.

50 The treatment for lung cancer depends on the type of cancer, how far it has spread and how good the patient's general health is. If the condition is diagnosed early and the cancerous cells are confined to a small area, surgery to remove the affected area of lung is usually recommended. If surgery is unsuitable, radiotherapy to destroy the cancerous cells may be recommended instead. If the cancer has spread too far for surgery or radiotherapy to be effective, chemotherapy is usually used.

As lung cancer does not usually cause noticeable symptoms until it has spread through much of the lungs or into other parts of the body, the outlook for the condition is not as good as many other types of cancer.

60 Overall, about 1 in 3 people with the condition will live for at least a year after they are diagnosed and fewer than 1 in 10 people will live at least five years. However, survival rates can vary widely depending on how far the cancer has spread at the time of the diagnosis. Early diagnosis can make a big difference.

## 2. Symptoms of lung cancer

65 There are usually no signs or symptoms in the early stages of lung cancer. However, symptoms develop as the condition progresses.

The main symptoms of lung cancer are listed below:

- a cough that doesn't go away after two or three weeks
- a long-standing cough that gets worse
- persistent chest infections
- 70 • coughing up blood
- an ache or pain when breathing or coughing
- persistent breathlessness
- persistent tiredness or lack of energy
- loss of appetite or unexplained weight loss

75 Less common symptoms of lung cancer include:

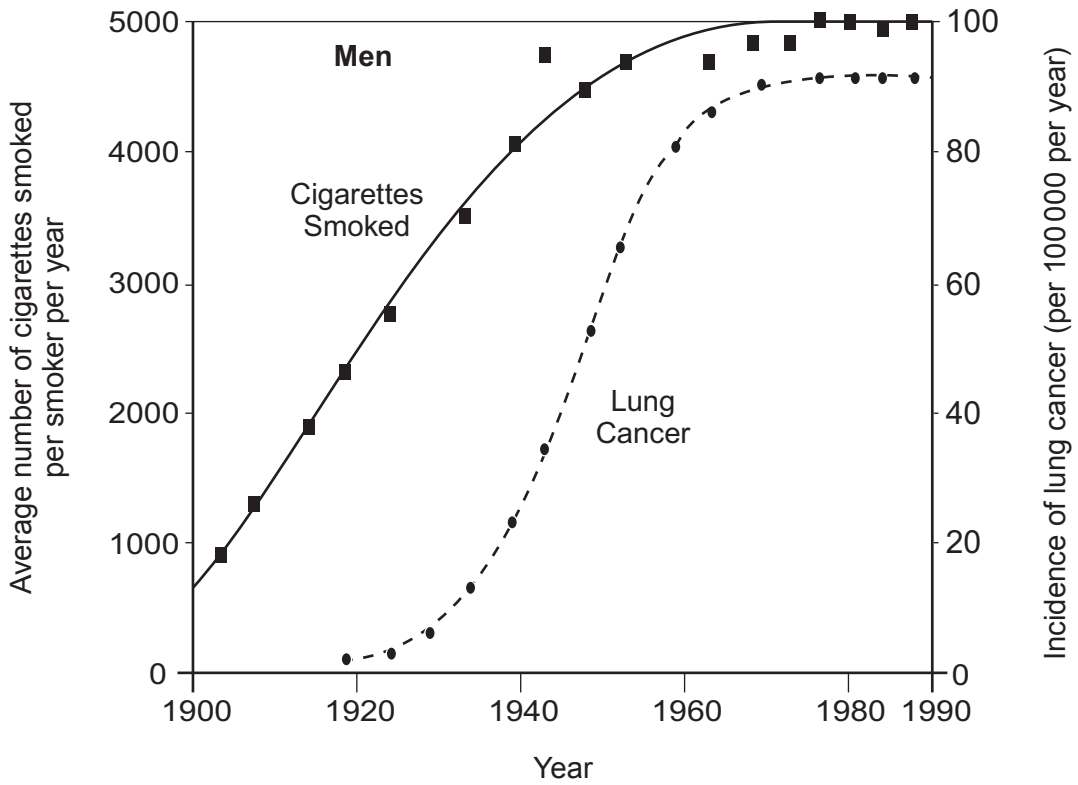
- changes in the appearance of the fingers, such as becoming more curved or their ends becoming larger – this is known as finger clubbing
- a high temperature (fever) of 38°C or above
- difficulty swallowing or pain when swallowing
- 80 • wheezing
- a hoarse voice
- swelling of your face or neck
- persistent chest or shoulder pain

## 3. Causes of lung cancer

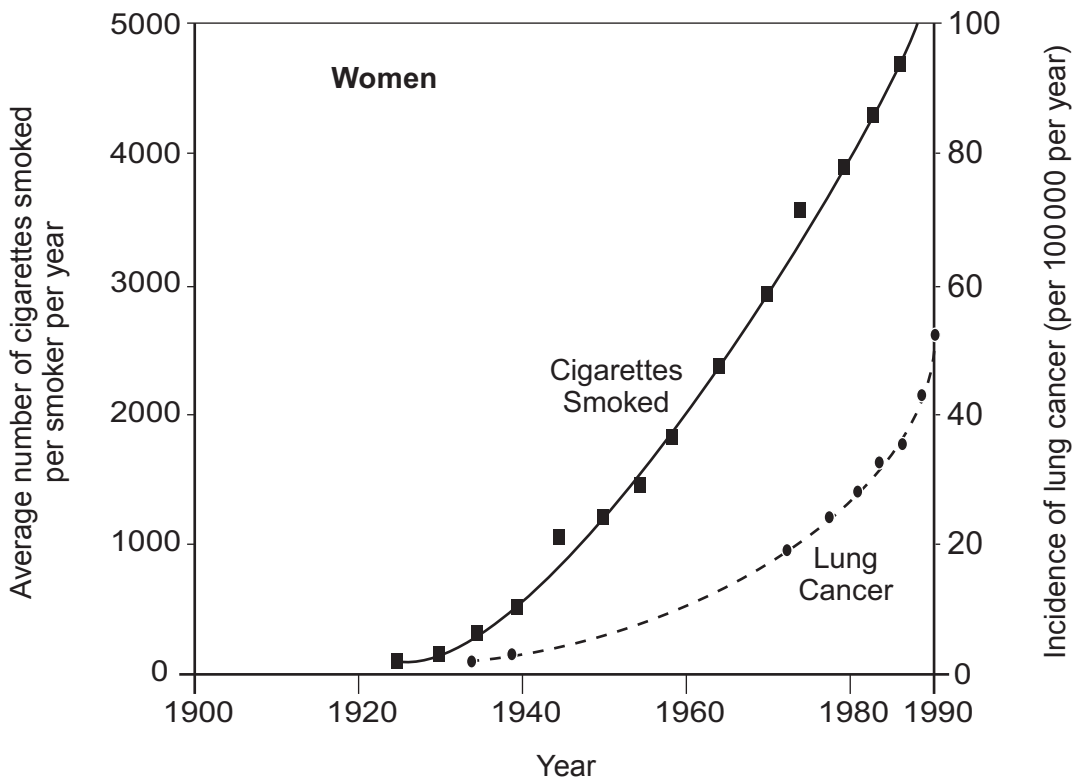
### 85 3.1 Smoking

Smoking cigarettes is the single biggest risk factor for lung cancer. It is responsible for about 90% of all cases.

90 Tobacco smoke contains more than 60 different toxic substances, which can lead to the development of cancer. These substances are known to be carcinogenic (cancer-producing). Smoking more than 25 cigarettes a day increases the risk of developing cancer by 25 times compared to non-smokers. Other types of tobacco products can also increase the risk of developing lung cancer and other types of cancer, such as oesophageal cancer and mouth cancer.



Graph 1 Average number of cigarettes smoked and incidence of lung cancer for men



Graph 2 Average number of cigarettes smoked and incidence of lung cancer for women

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### 3.2 Passive smoking

95 In non-smokers, frequent exposure to other people's tobacco  
 smoke (passive smoking) can increase the risk of developing lung  
 cancer. For example, research has found that non-smoking women  
 who share their house with a smoking partner are 25% more likely  
 100 to develop lung cancer than non-smoking women who live with a  
 non-smoking partner.



### 3.3 Radon

Radon is a naturally occurring radioactive gas that comes from tiny amounts of uranium  
 present in all rocks and soils. It can sometimes build up in buildings. If radon is breathed in,  
 it can damage the lungs, particularly in smokers. Radon is estimated to be responsible for  
 105 about 3% of all lung cancer deaths in the UK.

### 3.4 Occupational exposure and pollution

Exposure to certain chemicals and substances that are used in several occupations and  
 industries has been linked to a slightly higher risk of developing lung cancer. These chemicals  
 and substances include arsenic, asbestos, beryllium, cadmium, coal and coke fumes, silica  
 110 and nickel. Research also suggests that being exposed to large amounts of diesel fumes for  
 many years may increase the risk of developing lung cancer by up to 50%. One study has  
 shown that the risk of developing lung cancer increases by about a third if you live in an area  
 with high levels of nitrogen oxide gases (mostly produced by cars and other vehicles).

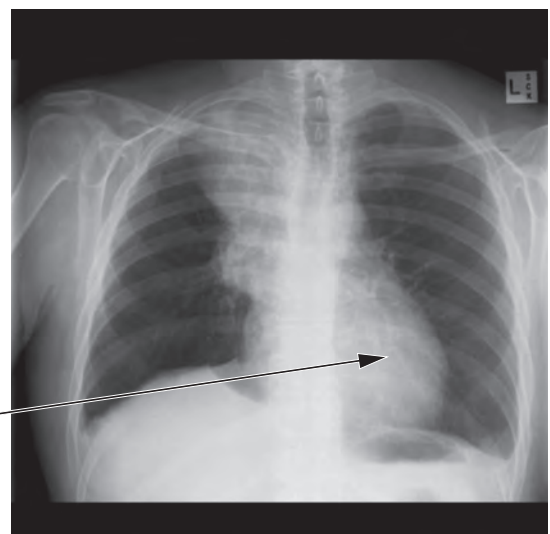
## 4. Diagnosing lung cancer

115 A patient should see their GP if they have symptoms of lung cancer, such as breathlessness  
 or a persistent cough. The GP may examine the patient and ask them to breathe into a  
 spirometer to test lung function. A blood test may be required to rule out some other conditions  
 such as chest infection. If the patient has been coughing up blood or has other persistent  
 signs of lung cancer, they should be referred for a chest X-ray or directly to a specialist in  
 120 chest conditions within two weeks.

### 4.1 Chest X-ray

A chest X-ray is usually the first test that is  
 used to diagnose lung cancer. Most lung  
 tumours show up on X-rays as a white-grey  
 125 mass. However, chest X-rays cannot give  
 a definitive diagnosis because they often  
 cannot distinguish between cancer and  
 other conditions, such as a lung abscess  
 (a collection of pus that forms in the lungs).

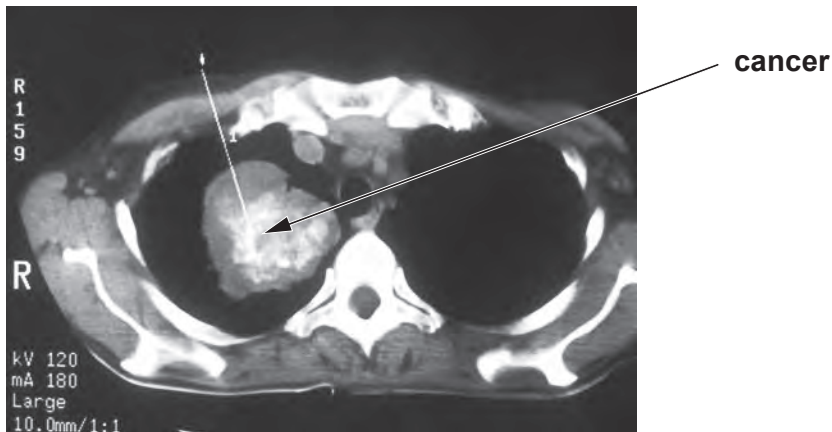
cancer



**Figure 2 Chest X-ray of a person with lung cancer**

## 130 4.2 CT scan

A computerised tomography (CT) scan is usually carried out after a chest X-ray. A CT scan uses X-rays and a computer to create detailed images of the inside of the body. Before having a CT scan, the patient is given an injection of a contrast medium. The scan is painless and takes 10-30 minutes to complete.



135 **Figure 3 CT scan**

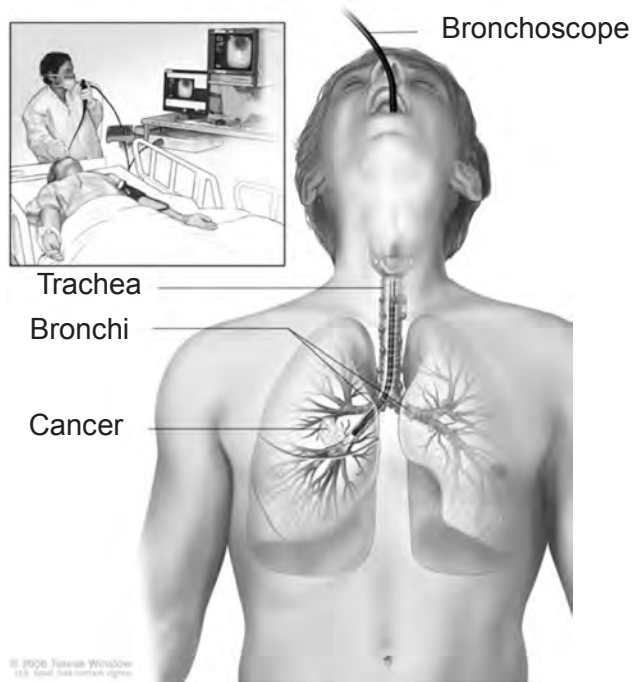
## 4.3 PET scan

A PET scan (positron emission tomography scan) may be carried out if the results of the CT scan show that the cancer is at an early stage. The PET scan can show where there are active cancer cells. This can help with diagnosis and treatment. Before having a PET scan, the patient is injected with a slightly radioactive material which is rapidly taken up by cancerous cells. These cancerous cells then emit gamma rays that are imaged by the machine. The scan is painless and takes around 30-60 minutes to complete.

## 4.4 Bronchoscopy and biopsy

If the CT scan shows that there might be cancer in the central part of the chest, a bronchoscopy may be conducted. This is a procedure that allows a doctor or nurse to remove a small sample of cells from inside the lungs. During a bronchoscopy, a thin tube called a bronchoscope is used to examine the lungs and take a sample of cells (biopsy). The bronchoscope is passed through the mouth or nose, down the throat and into the airways of the lungs.

The procedure can be uncomfortable, but patients are given a mild sedative beforehand to help them relax and a local anaesthetic to make the throat numb. The procedure is very quick and only takes a few minutes.



**Figure 4 Bronchoscopy**

155 Once the tests have been completed, it should be possible to work out at what stage the cancer is, what this means for treatment and whether it's possible to completely cure the cancer.

## 5. Treating lung cancer

The type of treatment received for lung cancer depends on several factors, including:

- the type of lung cancer (non-small-cell or small-cell cancer)
- the size and position of the cancer
- 160 • how far advanced the cancer is (the stage)
- overall health

The main treatment options include surgery, radiotherapy and chemotherapy.

### 5.1 Surgery

There are three types of lung cancer surgery:

- 165 • **lobectomy** – where one or more large parts of the lung (called lobes) are removed. Doctors will suggest this operation if the cancer is just in one section of one lung.
- **pneumonectomy** – where the entire lung is removed. This is used when the cancer is located in the middle of the lung or has spread throughout the lung.
- 170 • **wedge resection** – where a small piece of the lung is removed. This procedure is only suitable for a small number of patients where the cancer is small and limited to only one area of the lung.



175 People are naturally concerned that they will not be able to breathe if some or all of a lung is removed, but it is possible to breathe normally with one lung. However, if a patient has breathing problems before the operation, it is likely that these symptoms will continue after surgery.

Before surgery can take place, a number of tests to check general state of health and lung function are carried out. These may include:

- an electrocardiograph (ECG)
- spirometry

## 180 5.2 Radiotherapy

Radiotherapy is a type of treatment that uses radiation to destroy cancer cells. Radiotherapy can also be used to control the symptoms and slow the spread of cancer when a cure is not possible.

Side effects of radiotherapy to the chest include:

- 185
- chest pain
  - fatigue
  - persistent cough that may bring up blood-stained phlegm
  - difficulties swallowing
  - redness and soreness of the skin, which looks and feels like sunburn
- 190
- hair loss on the chest

## 5.3 Chemotherapy

Chemotherapy uses powerful cancer-killing drugs. There are several different ways that chemotherapy can be used to treat lung cancer. For example, it can be:

- 195
- given before surgery to shrink a tumour, which can increase the chance of successful surgery
  - given after surgery to prevent the cancer returning
  - used to relieve symptoms and slow the spread of cancer when a cure is not possible
  - combined with radiotherapy

200 Side effects of chemotherapy can include:

- fatigue
  - nausea
  - vomiting
  - mouth ulcers
- 205
- hair loss

Side effects of **both** radiotherapy and chemotherapy normally gradually pass once the treatment has finished. Radiotherapy and chemotherapy can also weaken the immune system, making patients more vulnerable to infection.

## 5.4 The type of lung cancer and treatment

### 210 5.4.1 Non-small-cell lung cancer treatment plan

If a patient has non-small-cell lung cancer that is confined to one lung and they are in good general health, they will probably have surgery to remove the cancerous cells. This may be followed by a course of chemotherapy to destroy any cancer cells that may have remained in the body.

215 If the cancer has not spread too far but surgery is not possible, radiotherapy to destroy the cancerous cells will usually be recommended. In some cases, this may be combined with chemotherapy. If the cancer has spread too far for surgery or radiotherapy to be effective, chemotherapy is usually recommended.

220 In some cases, a treatment called biological or targeted therapy may be recommended as an alternative to chemotherapy, or after chemotherapy. Biological therapies are medications that can control or stop the growth of cancer cells.

### 5.4.2 Small-cell lung cancer treatment plan

225 Small-cell lung cancer is usually treated with chemotherapy, either on its own or in combination with radiotherapy. This can help prolong life and relieve symptoms. Surgery isn't usually used to treat this type of lung cancer. This is because often the cancer has already spread to other areas of the body by the time it's diagnosed. However, if the cancer is found very early, surgery may be used. In these cases, chemotherapy or radiotherapy may be given after surgery to help reduce the risk of the cancer returning.

## 6. Preventing lung cancer

### 230 Smoking

The best way to prevent lung cancer and other serious conditions is by not smoking. For smokers, however long they have smoked, it is always worth quitting. After 10 years of not smoking, the chances of developing lung cancer falls to half that of a smoker.

### Diet

235 Research suggests that eating a low-fat, high-fibre diet, including at least five portions a day of fresh fruit and vegetables and plenty of whole grains, can help reduce the risk of lung cancer, as well as other types of cancer and heart disease.

### Exercise

240 There is strong evidence to suggest that regular exercise can lower the risk of developing lung cancer and other types of cancer. Adults should do at least 150 minutes (2 hours and 30 minutes) of moderate-intensity aerobic activity each week.

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**SECTION A***Answer all questions.*

1. State the names of the **three** types of non-small-cell lung cancer. [1]

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2. State **two** symptoms of lung cancer. [1]

.....

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3. Calculate the percentage of the UK population diagnosed with lung cancer every year. (The population of the UK is 70 000 000 (70 million).) [2]

.....

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4. Inhaling a number of toxic chemicals is linked with the development of lung cancer. Complete the table below to show the mechanism of breathing in (inspiration) and breathing out (expiration). The first line is completed for you. [4]

Component	Inspiration	Expiration
External Intercostal Muscles	Contract	Relax
Ribcage	.....	.....
Diaphragm	.....	.....
Volume of Thorax	.....	.....
Pressure of Thorax	.....	.....

5. Use **Graph 1** and **Graph 2** on page 5 to answer the following questions.

(a) Compare the trends in smoking in women and men, between 1900 and 1990. [2]

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.....

(b) Describe the link between smoking and lung cancer. [2]

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6. A person has a white blood cell count of  $12 \times 10^9 \text{ dm}^{-3}$ . Use the data sheet to explain if this blood test result indicates the person has a lung infection. [2]

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7. A spirometer can be used to diagnose lung cancer.

(a) A nurse is testing the lung function of a patient. Describe the standard procedure for using a spirometer. [4]

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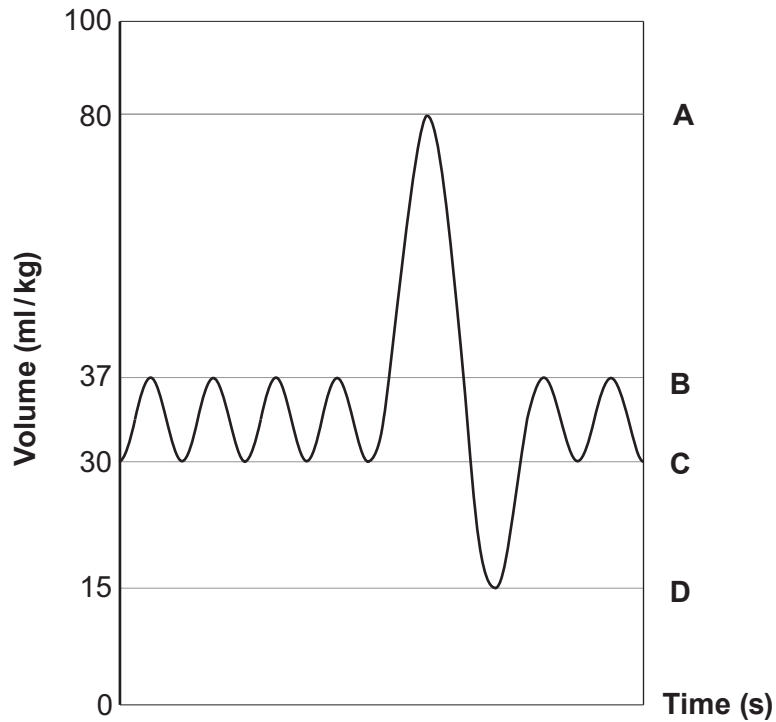
(b) A normal spirometer trace is shown below. State which **two** letters (A, B, C, D) would be used to determine:

(i) the tidal volume; [1]

.....

(ii) vital capacity. [1]

.....



(c) Draw on the trace the expected change(s) in a lung cancer patient. [1]

- 8. (a) A chest X-ray can also be used to diagnose lung cancer. Describe how an **image** is produced by X-ray. *You are not required to describe how X-rays are produced.* [3]

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- (b) State **two** safety precautions to prevent over-exposure to the radiographer. [2]

1. ....

2. ....

- (c) A contrast medium is often used with X-rays and CT scans. Explain why a contrast medium is used. [1]

.....

.....

- 9. A number of surgical procedures can be used to treat lung cancer. Describe **one** benefit and **one** risk of surgery. [2]

Benefit: .....

Risk: .....

.....

**SECTION B***Answer all questions.*

10. The table below shows the number of hospital admissions in Wales due to cardiac disease by Local Health Board in 2010.

Health Board	Mean age of population served by board	Population served by board	Number of women admitted	Number of men admitted	Total admissions
<b>A</b>	40.1	690 000	4 448	5 518	9 966
<b>B</b>	41.0	450 000	4 955	6 034	10 989
<b>C</b>	40.2	525 000	6 376	7 910	14 286
<b>D</b>	40.5	295 000	3 344	4 094	.....
<b>E</b>	40.1	280 000	2 856	3 439	6 295
<b>F</b>	39.8	300 000	3 394	4 554	7 948
<b>G</b>	40.1	135 000	1 105	1 543	2 648
				Total	.....

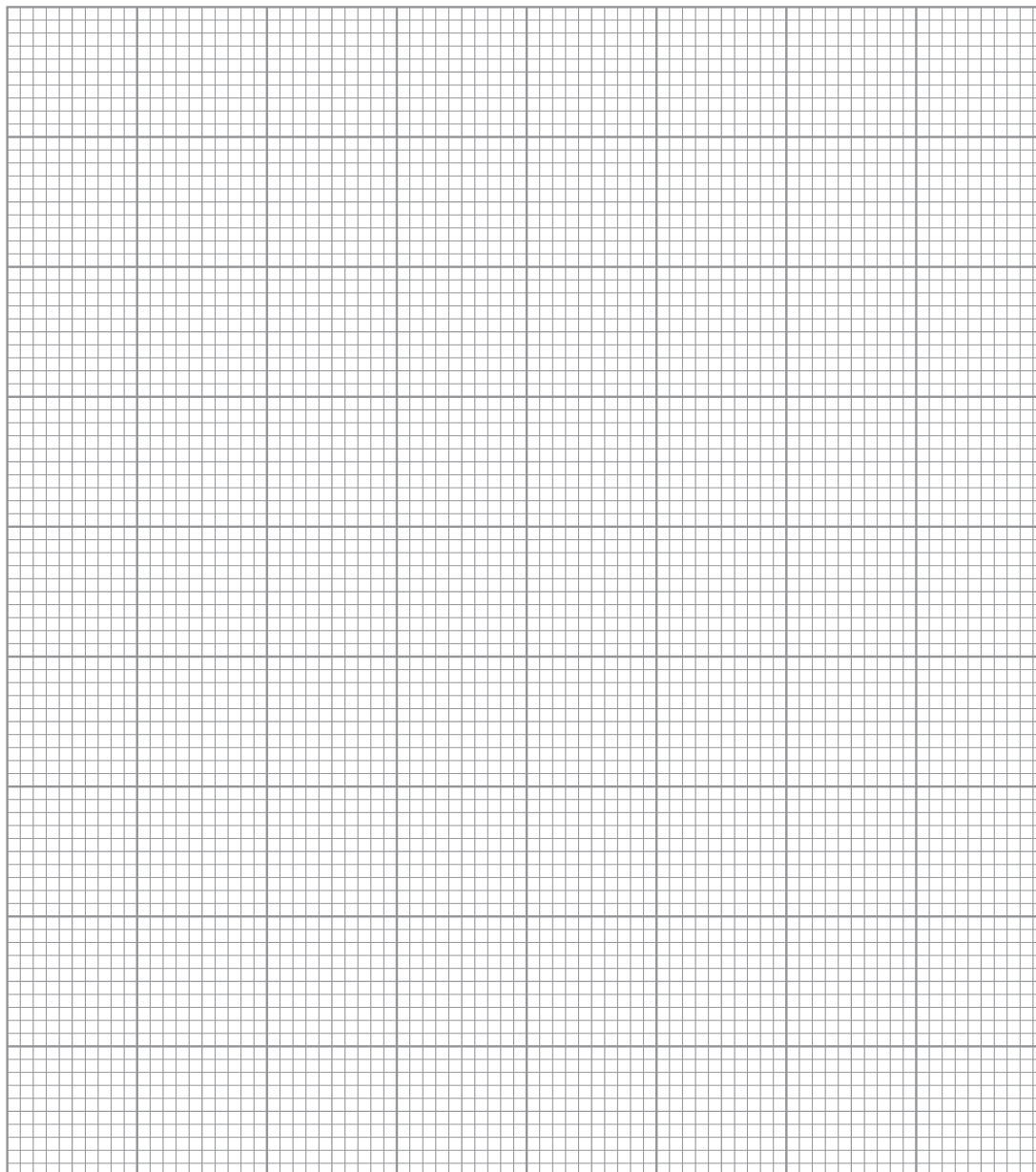
- (a) Complete the table by calculating the missing values.

[1]



(b) Plot the data for men and women in Health Boards **A-G**.

[4]



(c) Compare the number of hospital admissions for men and women.

[1]

(d) Health Board **G** covers the largest area of Wales but has the lowest number of admissions for cardiac disease. Suggest why Health Board **G** has the lowest number of admissions.

[1]

.....

.....

(e) Coronary heart disease is the most common form of cardiac disease.

(i) State **two** causes of coronary heart disease. [2]

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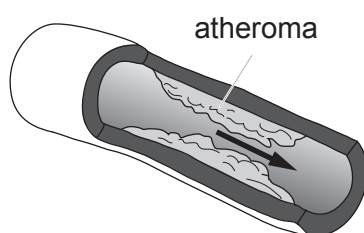
(ii) What is the function of the coronary arteries and where are they located? [2]

Function: .....

.....

Location: .....

.....



(iii) Atheromas form in the coronary arteries during coronary heart disease. Suggest **two** effects of atheromas **on the heart**. [2]

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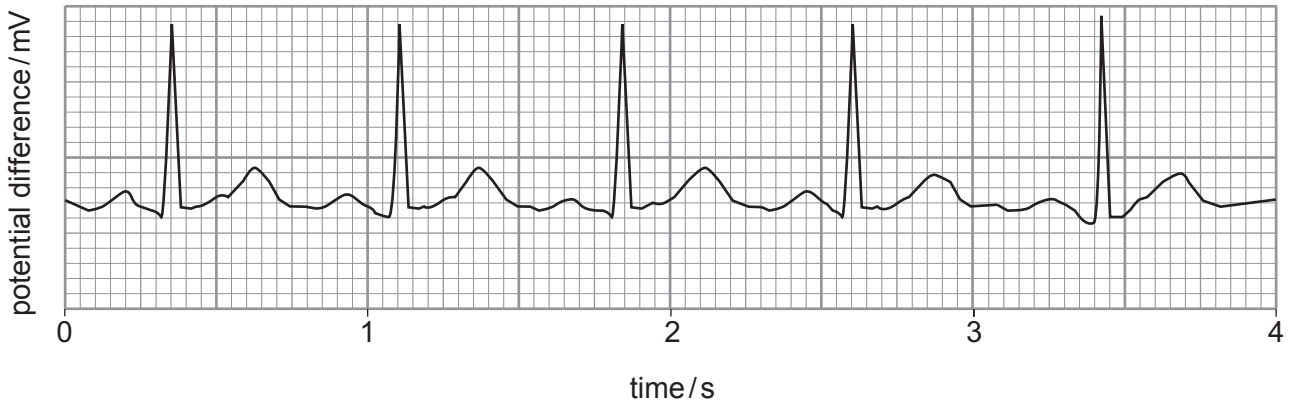
(iv) The number of deaths in Wales from coronary heart disease has decreased in the last 10 years. Suggest **two** reasons for this decrease. [2]

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11. Brian is carrying out an ECG on a patient. The following normal ECG trace is obtained:



(a) (i) Calculate the average resting heart rate for this person in beats per minute. [2]

..... beats per minute

(ii) State how the trace would be different if the patient suffered from tachycardia or bradycardia. [2]

Tachycardia: .....

Bradycardia: .....

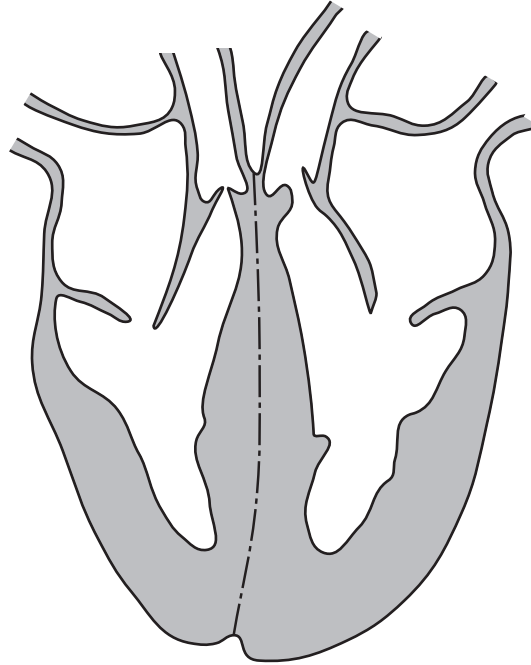
(b) Some patients suffer from an 'abnormal P wave'.

(i) Mark the position of the 'P wave' on one segment of the ECG above. [1]

(ii) State what part of the cardiac cycle is represented by the 'P wave'. [1]

.....

- (c) (i) On the diagram of the heart below, label the position of the sinoatrial node and Purkinje (Purkyne) fibres. [2]



- (ii) Describe the path of electrical excitation through the heart during the cardiac cycle. [3]

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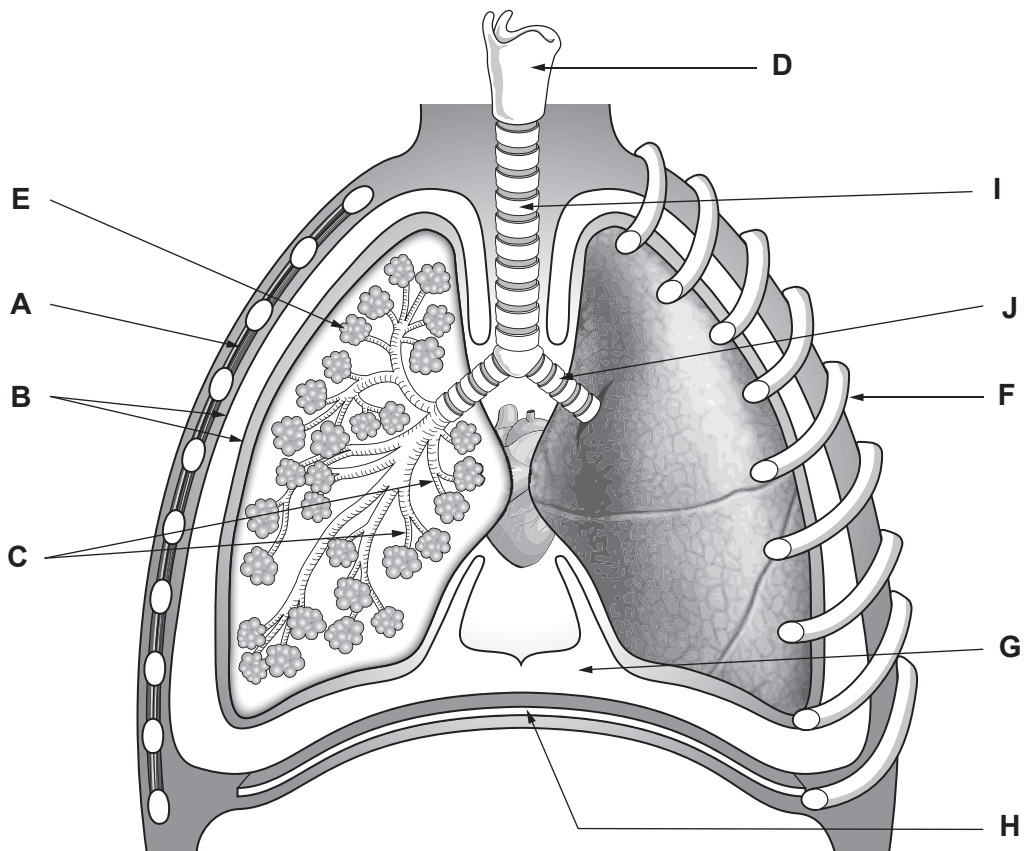
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12. The diagram below shows the human respiratory system.



(a) Complete the table below, matching the correct letter(s) from the diagram to their description. [3]

Description	Letter(s)
contain cilia to waft mucus	.....
constrict during asthma attack	.....
broken down during emphysema	.....

(b) Describe the process of gas exchange in structure **E**. [3]

.....

.....

.....

.....

.....

(c) (i) State **three** ways in which structure **E** is adapted for its function. [3]

.....

.....

.....

(ii) Describe how **two** of these adaptations listed in part (c)(i) aids **gas exchange**. [2]

Adaptation 1 .....

Description .....

.....

.....

Adaptation 2 .....

Description .....

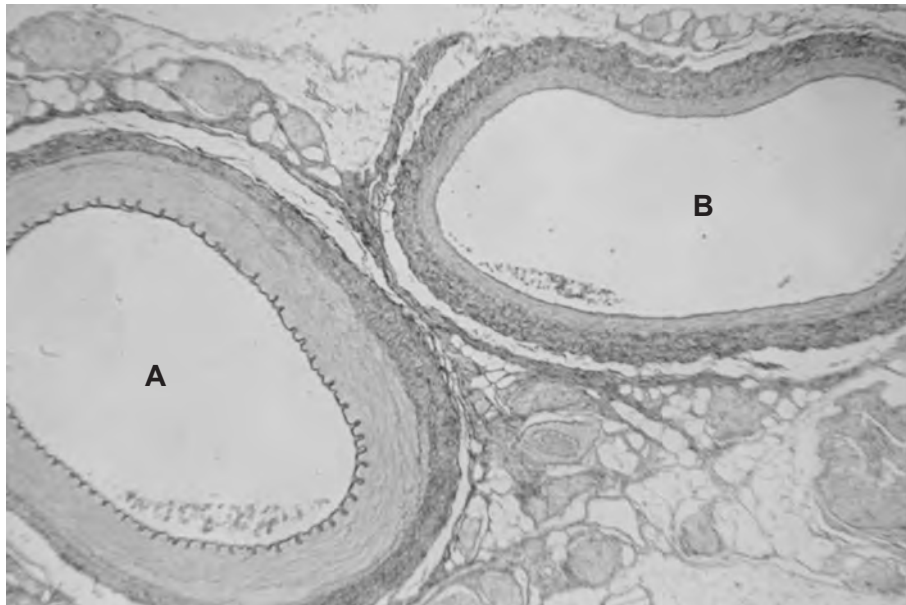
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13. Sarah is studying different types of vessel found in the tissues of the human body. She observed the vessels below under a light microscope.



(a) (i) State the name of vessels **A** and **B**. [2]

**A** .....

**B** .....

(ii) State **two** ways in which vessel **B** is adapted for its function and explain the importance of each adaptation. [4]

1. ....

.....

.....

.....

2. ....

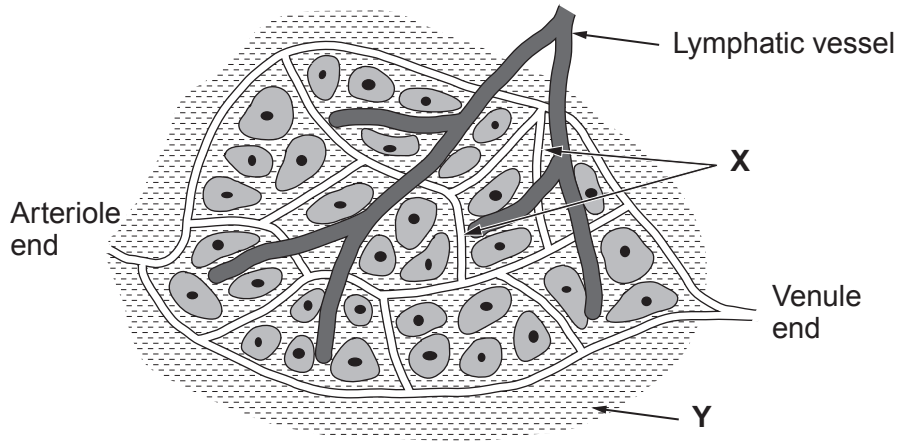
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She also looked at this diagram of human blood vessels.



(b) (i) State the name of: [2]

Vessel X: .....

Fluid Y: .....

(ii) State **two** features of vessel X which enable the formation of fluid Y. [2]

1. ....

2. ....

(c) Haemoglobin gives blood its characteristic colour.

(i) State the component of blood in which haemoglobin is found. [1]

.....

(ii) State the function of haemoglobin. [1]

.....

(iii) Explain why there is no haemoglobin in fluid Y. [2]

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**Data Sheet****Table 1** Normal values for some physiological indicators

Indicator	Adult Male	Adult Female
Pulse Rate	60 – 80 beats per minute	60 – 80 beats per minute
<b>BREATHING</b>		
Rate	12 – 15 breaths per minute	12 – 15 breaths per minute
Tidal volume	400 – 500 cm <sup>3</sup>	400 – 500 cm <sup>3</sup>
Vital Capacity	4.8 dm <sup>3</sup>	3.1 dm <sup>3</sup>
Peak Flow	400 – 600 dm <sup>3</sup> min <sup>-1</sup>	400 – 600 dm <sup>3</sup> min <sup>-1</sup>
<b>BLOOD PRESSURE</b>		
20 years old	125/80 mmHg	123/80 mmHg
40 years old	135/85 mmHg	133/85 mmHg

**Table 2** Reference ranges for some common blood tests

Test	Adult Male	Adult Female
Glucose (Fasting)	4.5 – 6.1 mmol dm <sup>-3</sup>	4.5 – 6.1 mmol dm <sup>-3</sup>
Sodium ions	133 – 147 mmol dm <sup>-3</sup>	133 – 147 mmol dm <sup>-3</sup>
Potassium ions	3.5 – 5.0 mmol dm <sup>-3</sup>	3.5 – 5.0 mmol dm <sup>-3</sup>
Calcium ions	1.15 – 1.29 mmol dm <sup>-3</sup>	1.15 – 1.29 mmol dm <sup>-3</sup>
Zinc ions	10 – 17 µmol dm <sup>-3</sup>	10 – 17 µmol dm <sup>-3</sup>
<b>RED BLOOD CELLS</b>		
Haemoglobin	140 – 180 g dm <sup>-3</sup>	115 – 160 g dm <sup>-3</sup>
Red Cell count	4.5 – 6.5 × 10 <sup>12</sup> dm <sup>-3</sup>	3.8 – 5.8 × 10 <sup>12</sup> dm <sup>-3</sup>
<b>WHITE BLOOD CELL COUNT</b>	4 – 11 × 10 <sup>9</sup> dm <sup>-3</sup>	4 – 11 × 10 <sup>9</sup> dm <sup>-3</sup>
<b>PLATELET COUNT</b>	150 – 400 × 10 <sup>9</sup> dm <sup>-3</sup>	150 – 400 × 10 <sup>9</sup> dm <sup>-3</sup>



**GCE AS/A level**

1661/01-A



S16-1661-01A

**APPLIED SCIENCE**

**UNIT 1**

**Pre-release Article for Examination in  
May 2016**

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01A001

**Information for Teachers**

The pre-release article is intended as stimulus material in order to generate discussion. Questions will be set on the examination paper based on the information in the article and related aspects from the specification.

The article is based upon information found on various websites including:

[http://www2.lifewithlungcancer.info/experts/Hope\\_Through\\_Research/6/radiopaedia.org/articles/small-cell-lung-cancer-1](http://www2.lifewithlungcancer.info/experts/Hope_Through_Research/6/radiopaedia.org/articles/small-cell-lung-cancer-1)

<http://www.webmd.com/lung-cancer/ss/slideshow-lung-cancer-overview>

<http://www.cancer.gov/cancertopics/pdq/treatment/small-cell-lung/Patient/page1>

[www.nhs.uk/Conditions/Cancer-of-the-lung/Pages/Introduction.aspx](http://www.nhs.uk/Conditions/Cancer-of-the-lung/Pages/Introduction.aspx)

**No recall or terminology is required over and above that in the specification.**

Candidates will be expected to have discussed and studied the article together with relevant specification content prior to the examination. However, they will not be expected to memorise any part of it as a copy will be provided in the examination paper.

## **‘I didn’t fit the typical profile of someone with lung cancer’ Lung cancer: Iwan’s story**

Iwan was diagnosed with lung cancer after visiting his GP with pain and swelling in his knees. “My symptoms were quite unusual for lung cancer. It began with a swelling on my knees, so I went to my GP who X-rayed them. There was nothing structurally wrong, so he gave me some anti-inflammatory drugs. It didn’t seem to improve the situation. I have two small children, so I’m up and down on my knees quite a bit, and it was becoming quite painful. I went to see a rheumatologist, who gave me a complete examination and checked my knees and my fingers. She noticed that my hands had finger clubbing, which is a swelling of the ends of the fingers.”

“As a precaution, she ordered a chest X-ray, because this condition could be a sign of chest problems, such as bronchitis. Fifteen minutes later she came back with the X-ray, which showed I had a huge shadow on my right lung. I was referred to a chest physician, who did some further tests. Those confirmed I had a syndrome called hyper pulmonary osteoarthritis (HPOA), where the lining of the bones becomes thick. It’s often associated with non-small-cell lung cancer.”

“Lung cancer is statistically associated with smoking, and 80% of cases are linked with smoking. I smoked 15 years ago but I hadn’t smoked for many years because of the children. I didn’t fit the typical profile of a lung cancer sufferer who smokes 20-40 cigarettes a day.”

“In the right lung you have three lobes. Surgeons cut a hole in my back and removed one of the lobes and basically joined it back together. They probably removed about a third of my right lung. But about four weeks after surgery, I was feeling better. I didn’t have any major side effects from chemotherapy, so I was quite fit and active. But radiotherapy made my oesophagus very inflamed and it was incredibly painful for me to swallow.”

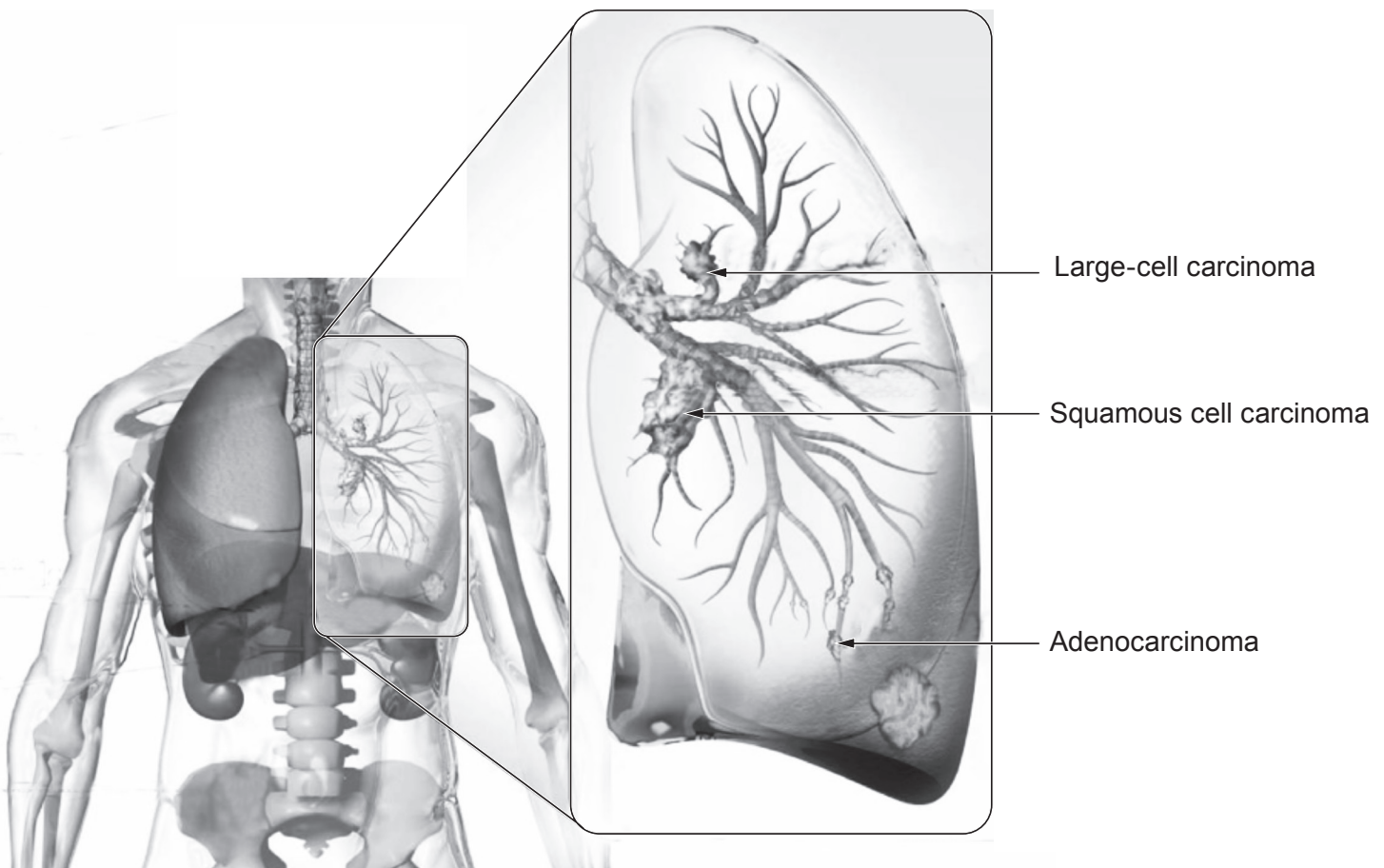
“One of the things that I found most helpful was the cancer nurse specialists. They were excellent at being sympathetic, answering questions and giving advice. I would suggest that anyone going through the same thing should use all of the available resources and try to find something positive to focus on.”

## 30 1. Introduction

Lung cancer is one of the most common and serious types of cancer. Over 41 000 people are diagnosed with the condition every year in the UK. There are usually no signs or symptoms in the early stages of lung cancer, but many people with the condition will eventually develop symptoms such as persistent cough, persistent breathlessness, persistent tiredness, weight loss and pain when breathing or coughing.

Cancer that begins in the lungs is called primary lung cancer. There are two main types of primary lung cancer. These are classified by the type of cells in which the cancer starts. They are:

- 40 • **small-cell lung cancer** – the least common type that usually spreads faster than non-small-cell lung cancer
- **non-small-cell lung cancer** – the most common type, accounting for more than 80% of cases; can be either squamous cell carcinoma, adenocarcinoma or large-cell carcinoma



**Figure 1 Areas affected by cancerous cells**

45 Lung cancer mainly affects older people. It is rare in people younger than 40, but the rates of lung cancer rise sharply with age. Lung cancer is most commonly diagnosed in people aged 70-74 years. Although people who have never smoked can develop lung cancer, smoking is the main cause (about 90% of cases). This is because smoking involves regularly inhaling a number of different toxic substances.



50 The treatment for lung cancer depends on the type of cancer, how far it has spread and how good the patient's general health is. If the condition is diagnosed early and the cancerous cells are confined to a small area, surgery to remove the affected area of lung is usually recommended. If surgery is unsuitable, radiotherapy to destroy the cancerous cells may be recommended instead. If the cancer has spread too far for surgery or radiotherapy to be effective, chemotherapy is usually used.

As lung cancer does not usually cause noticeable symptoms until it has spread through much of the lungs or into other parts of the body, the outlook for the condition is not as good as many other types of cancer.

60 Overall, about 1 in 3 people with the condition will live for at least a year after they are diagnosed and fewer than 1 in 10 people will live at least five years. However, survival rates can vary widely depending on how far the cancer has spread at the time of the diagnosis. Early diagnosis can make a big difference.

## 2. Symptoms of lung cancer

65 There are usually no signs or symptoms in the early stages of lung cancer. However, symptoms develop as the condition progresses.

The main symptoms of lung cancer are listed below:

- a cough that doesn't go away after two or three weeks
- a long-standing cough that gets worse
- persistent chest infections
- 70 • coughing up blood
- an ache or pain when breathing or coughing
- persistent breathlessness
- persistent tiredness or lack of energy
- loss of appetite or unexplained weight loss

75 Less common symptoms of lung cancer include:

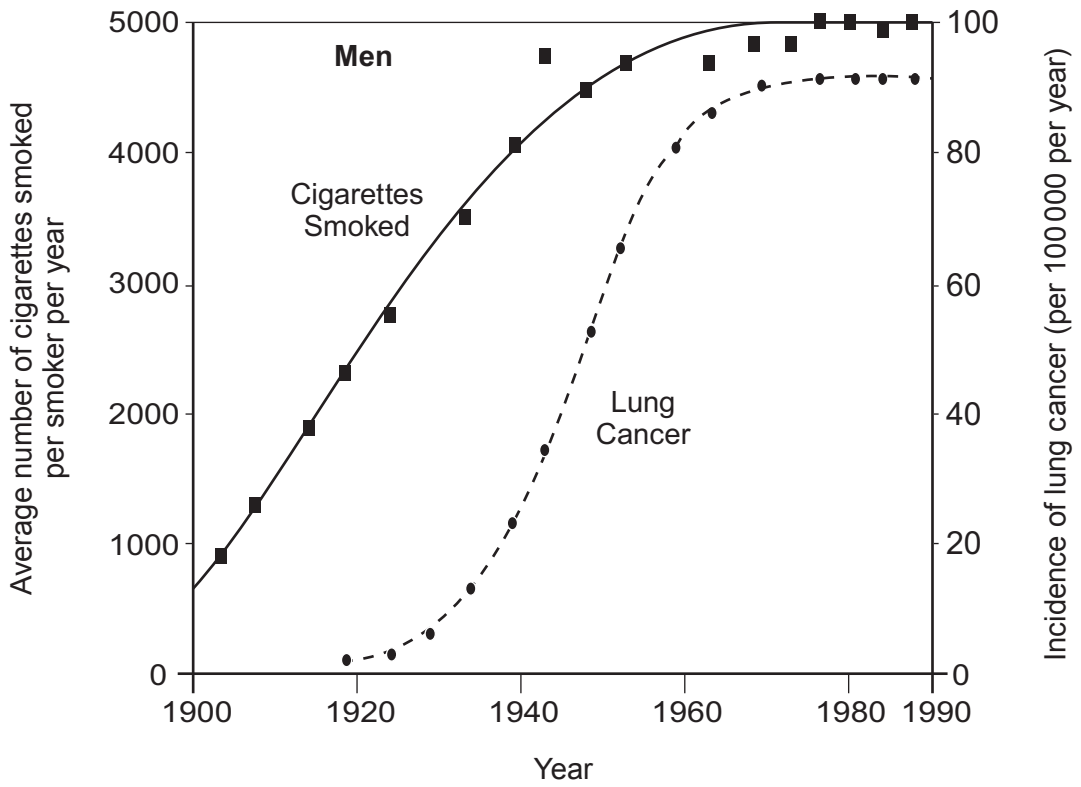
- changes in the appearance of the fingers, such as becoming more curved or their ends becoming larger – this is known as finger clubbing
- a high temperature (fever) of 38°C or above
- difficulty swallowing or pain when swallowing
- 80 • wheezing
- a hoarse voice
- swelling of your face or neck
- persistent chest or shoulder pain

## 3. Causes of lung cancer

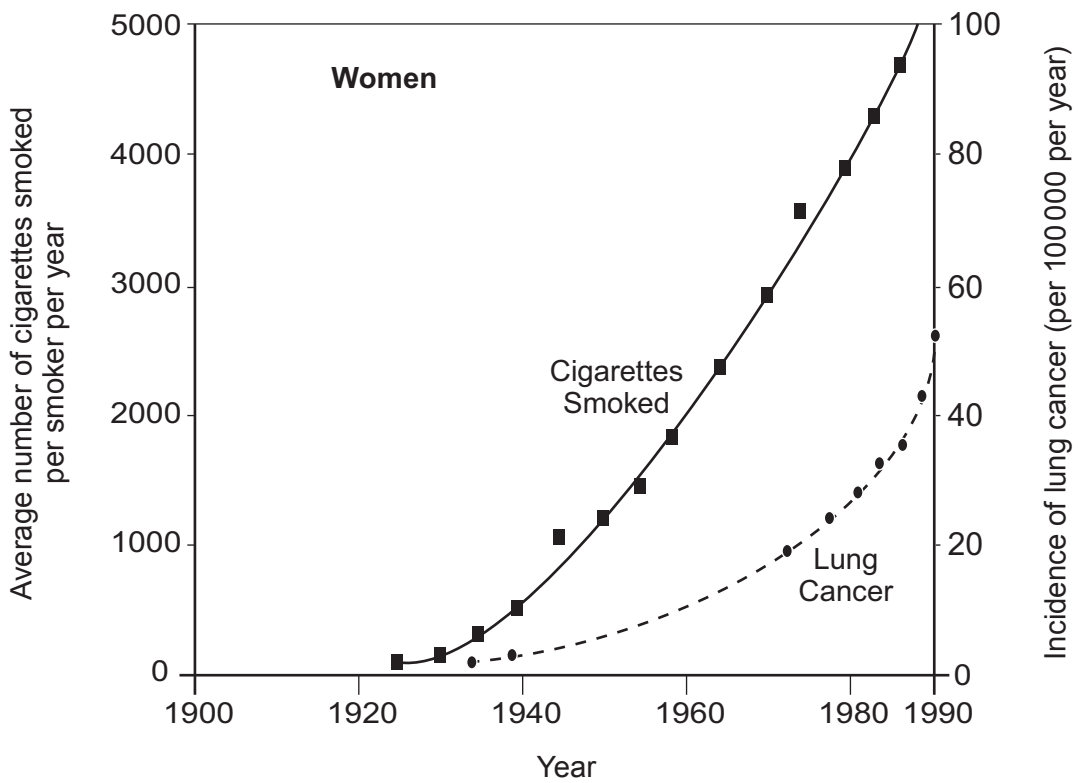
### 85 3.1 Smoking

Smoking cigarettes is the single biggest risk factor for lung cancer. It is responsible for about 90% of all cases.

90 Tobacco smoke contains more than 60 different toxic substances, which can lead to the development of cancer. These substances are known to be carcinogenic (cancer-producing). Smoking more than 25 cigarettes a day increases the risk of developing cancer by 25 times compared to non-smokers. Other types of tobacco products can also increase the risk of developing lung cancer and other types of cancer, such as oesophageal cancer and mouth cancer.



**Graph 1 Average number of cigarettes smoked and incidence of lung cancer for men**



**Graph 2 Average number of cigarettes smoked and incidence of lung cancer for women**

### 3.2 Passive smoking

95 In non-smokers, frequent exposure to other people's tobacco  
 smoke (passive smoking) can increase the risk of developing lung  
 cancer. For example, research has found that non-smoking women  
 who share their house with a smoking partner are 25% more likely  
 100 to develop lung cancer than non-smoking women who live with a  
 non-smoking partner.



### 3.3 Radon

Radon is a naturally occurring radioactive gas that comes from tiny amounts of uranium  
 present in all rocks and soils. It can sometimes build up in buildings. If radon is breathed in,  
 it can damage the lungs, particularly in smokers. Radon is estimated to be responsible for  
 105 about 3% of all lung cancer deaths in the UK.

### 3.4 Occupational exposure and pollution

Exposure to certain chemicals and substances that are used in several occupations and  
 industries has been linked to a slightly higher risk of developing lung cancer. These chemicals  
 and substances include arsenic, asbestos, beryllium, cadmium, coal and coke fumes, silica  
 110 and nickel. Research also suggests that being exposed to large amounts of diesel fumes for  
 many years may increase the risk of developing lung cancer by up to 50%. One study has  
 shown that the risk of developing lung cancer increases by about a third if you live in an area  
 with high levels of nitrogen oxide gases (mostly produced by cars and other vehicles).

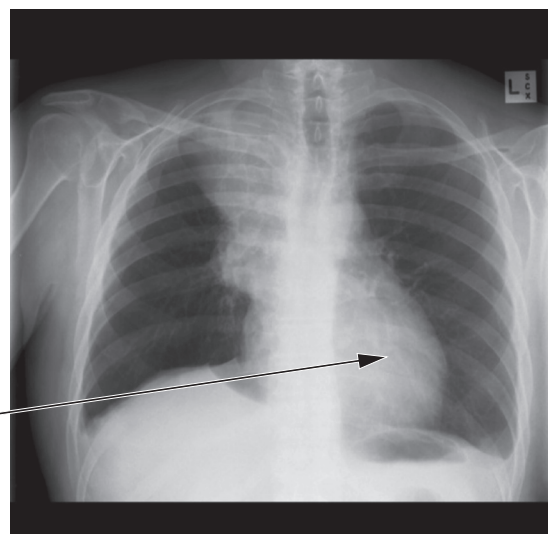
## 4. Diagnosing lung cancer

115 A patient should see their GP if they have symptoms of lung cancer, such as breathlessness  
 or a persistent cough. The GP may examine the patient and ask them to breathe into a  
 spirometer to test lung function. A blood test may be required to rule out some other conditions  
 such as chest infection. If the patient has been coughing up blood or has other persistent  
 signs of lung cancer, they should be referred for a chest X-ray or directly to a specialist in  
 120 chest conditions within two weeks.

### 4.1 Chest X-ray

125 A chest X-ray is usually the first test that is used to diagnose lung cancer. Most lung  
 tumours show up on X-rays as a white-grey mass. However, chest X-rays cannot give  
 a definitive diagnosis because they often cannot distinguish between cancer and  
 other conditions, such as a lung abscess (a collection of pus that forms in the lungs).

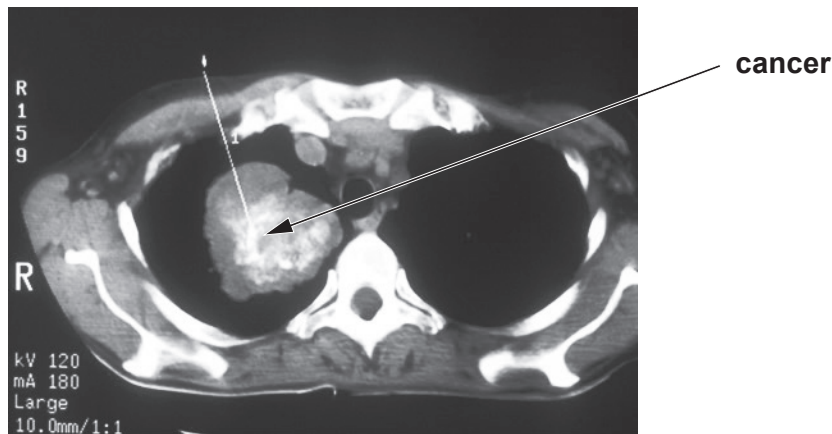
cancer



**Figure 2 Chest X-ray of person with lung cancer**

## 130 4.2 CT scan

A computerised tomography (CT) scan is usually carried out after a chest X-ray. A CT scan uses X-rays and a computer to create detailed images of the inside of the body. Before having a CT scan, the patient is given an injection of a contrast medium. The scan is painless and takes 10-30 minutes to complete.



135 **Figure 3 CT scan**

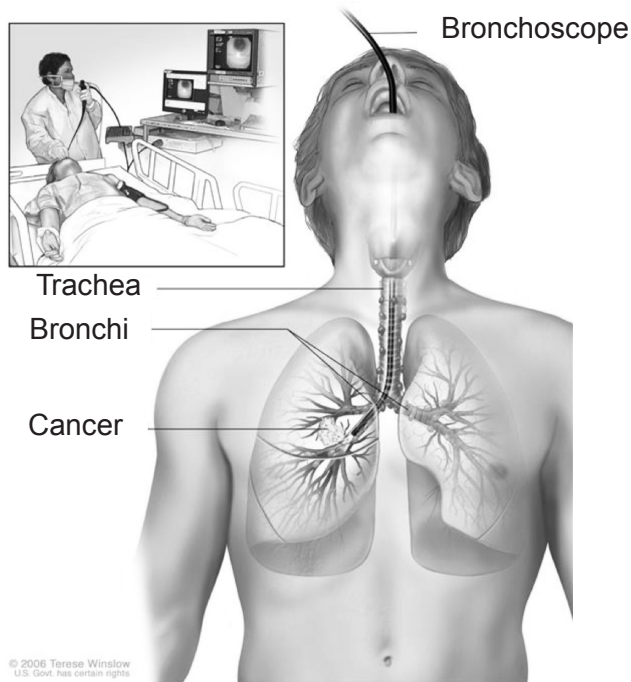
## 4.3 PET scan

A PET scan (positron emission tomography scan) may be carried out if the results of the CT scan show that the cancer is at an early stage. The PET scan can show where there are active cancer cells. This can help with diagnosis and treatment. Before having a PET scan, the patient is injected with a slightly radioactive material which is rapidly taken up by cancerous cells. These cancerous cells then emit gamma rays that are imaged by the machine. The scan is painless and takes around 30-60 minutes to complete.

## 4.4 Bronchoscopy and biopsy

If the CT scan shows that there might be cancer in the central part of the chest, a bronchoscopy may be conducted. This is a procedure that allows a doctor or nurse to remove a small sample of cells from inside the lungs. During a bronchoscopy, a thin tube called a bronchoscope is used to examine the lungs and take a sample of cells (biopsy). The bronchoscope is passed through the mouth or nose, down the throat and into the airways of the lungs.

The procedure can be uncomfortable, but patients are given a mild sedative beforehand to help them relax and a local anaesthetic to make the throat numb. The procedure is very quick and only takes a few minutes.



**Figure 4 Bronchoscopy**

155 Once the tests have been completed, it should be possible to work out at what stage the cancer is, what this means for treatment and whether it's possible to completely cure the cancer.

## 5. Treating lung cancer

The type of treatment received for lung cancer depends on several factors, including:

- 160
- the type of lung cancer (non-small-cell or small-cell cancer)
  - the size and position of the cancer
  - how far advanced the cancer is (the stage)
  - overall health

The main treatment options include surgery, radiotherapy and chemotherapy.

### 5.1 Surgery

There are three types of lung cancer surgery:

- 165
- **lobectomy** – where one or more large parts of the lung (called lobes) are removed. Doctors will suggest this operation if the cancer is just in one section of one lung.
  - **pneumonectomy** – where the entire lung is removed. This is used when the cancer is located in the middle of the lung or has spread throughout the lung.
  - **wedge resection** – where a small piece of the lung is removed. This procedure is only suitable for a small number of patients where the cancer is small and limited to only one area of the lung.
- 170

175 People are naturally concerned that they will not be able to breathe if some or all of a lung is removed, but it is possible to breathe normally with one lung. However, if a patient has breathing problems before the operation, it is likely that these symptoms will continue after surgery.

Before surgery can take place, a number of tests to check general state of health and lung function are carried out. These may include:

- an electrocardiograph (ECG)
- spirometry

## 180 5.2 Radiotherapy

Radiotherapy is a type of treatment that uses radiation to destroy cancer cells. Radiotherapy can also be used to control the symptoms and slow the spread of cancer when a cure is not possible.

Side effects of radiotherapy to the chest include:

- 185
- chest pain
  - fatigue
  - persistent cough that may bring up blood-stained phlegm
  - difficulties swallowing
  - redness and soreness of the skin, which looks and feels like sunburn
- 190
- hair loss on the chest

## 5.3 Chemotherapy

Chemotherapy uses powerful cancer-killing drugs. There are several different ways that chemotherapy can be used to treat lung cancer. For example, it can be:

- 195
- given before surgery to shrink a tumour, which can increase the chance of successful surgery
  - given after surgery to prevent the cancer returning
  - used to relieve symptoms and slow the spread of cancer when a cure is not possible
  - combined with radiotherapy

200 Side effects of chemotherapy can include:

- fatigue
  - nausea
  - vomiting
  - mouth ulcers
- 205
- hair loss

Side effects of **both** radiotherapy and chemotherapy normally gradually pass once the treatment has finished. Radiotherapy and chemotherapy can also weaken the immune system, making patients more vulnerable to infection.

## 5.4 The type of lung cancer and treatment

### 210 5.4.1 Non-small-cell lung cancer treatment plan

If a patient has non-small-cell lung cancer that is confined to one lung and they are in good general health, they will probably have surgery to remove the cancerous cells. This may be followed by a course of chemotherapy to destroy any cancer cells that may have remained in the body.

215 If the cancer has not spread too far but surgery is not possible, radiotherapy to destroy the cancerous cells will usually be recommended. In some cases, this may be combined with chemotherapy. If the cancer has spread too far for surgery or radiotherapy to be effective, chemotherapy is usually recommended.

220 In some cases, a treatment called biological or targeted therapy may be recommended as an alternative to chemotherapy, or after chemotherapy. Biological therapies are medications that can control or stop the growth of cancer cells.

### 5.4.2 Small-cell lung cancer treatment plan

225 Small-cell lung cancer is usually treated with chemotherapy, either on its own or in combination with radiotherapy. This can help prolong life and relieve symptoms. Surgery isn't usually used to treat this type of lung cancer. This is because often the cancer has already spread to other areas of the body by the time it's diagnosed. However, if the cancer is found very early, surgery may be used. In these cases, chemotherapy or radiotherapy may be given after surgery to help reduce the risk of the cancer returning.

## 6. Preventing lung cancer

### 230 Smoking

The best way to prevent lung cancer and other serious conditions is by not smoking. For smokers, however long they have smoked, it is always worth quitting. After 10 years of not smoking, the chances of developing lung cancer falls to half that of a smoker.

### Diet

235 Research suggests that eating a low-fat, high-fibre diet, including at least five portions a day of fresh fruit and vegetables and plenty of whole grains, can help reduce the risk of lung cancer, as well as other types of cancer and heart disease.

### Exercise

240 There is strong evidence to suggest that regular exercise can lower the risk of developing lung cancer and other types of cancer. Adults should do at least 150 minutes (2 hours and 30 minutes) of moderate-intensity aerobic activity each week.