

Surname	Centre Number	Candidate Number
Other Names		2



GCE AS/A level

1661/01

**APPLIED SCIENCE
UNIT 1**

A.M. THURSDAY, 15 May 2014

1 hour 30 minutes

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
Section A 1. – 11.	32	
Section B 12.	9	
13.	13	
14.	5	
15.	9	
16.	12	
Total	80	

ADDITIONAL MATERIALS

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

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.

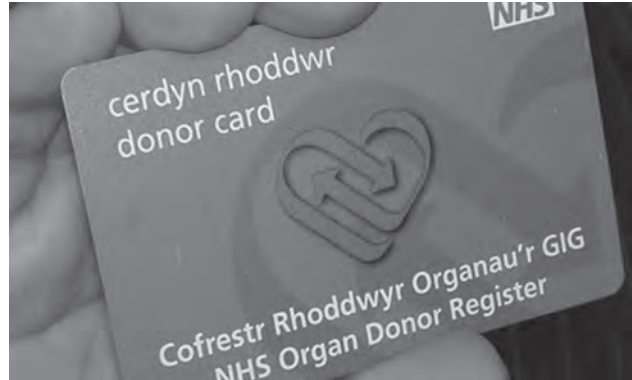
A **data sheet** is included on page 32.

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1 Organ donation: Opt-out bill to be published in Wales

Welsh government proposals would automatically add people to the organ donor register.

5 Legislation to change the organ donation system in Wales will be published soon. The Welsh government wants an opt-out scheme, which means everyone is assumed to have consented to becoming a donor when they die, and only those who object will be taken off the register.



10 Health Minister Lesley Griffiths has said she cannot imagine organs being removed if a family objects. Supporters say change will mean more organs being available for transplants. But church leaders have opposed the changes and the Law Society has called for more clarity on what role will be left for families when a relative dies. The reforms would make Wales the first country in the UK to adopt a system of presumed consent.

15 OPT-OUT LAW

20 Despite a record 83 people donating organs in 2010, the Welsh government said a shortage of organs continues to cause deaths and the system will improve donations. Opponents have said changing the law may not make a difference and could be counter-productive. With 300 people on the transplant waiting list, the Welsh government wants to improve the rate of organ donation. But the Church in Wales, the Roman Catholic Church in Wales and the Wales Orthodox Mission have called for a re-think, with other critics saying there is no evidence that changing the law will work.

25 'Talk to families'

30 A consultant in intensive care at Cardiff's University Hospital of Wales, said: "As doctors we are not going to do anything against family wishes. The role of the family is crucial and essential and will not change under this legislation. It is a terrible time to talk to families. It helps if you know what a patient's wishes are. If patients haven't opted out we would hope to talk to families about what organ donation is and the fact that a member of their family has expressed to be an organ donor and, hopefully, that could be followed through."

35 He said organ donation has increased by 50% in Wales over the last four years, and key to that has been the appointment of a specialist organ donation nurse at every hospital. But he said it was hoped those figures could improve further over time because the biggest "obstacle" is lack of family support after their relative dies which he hoped the new legislation would help to resolve.

The above article is adapted from a report published on the BBC website on 18 June 2012.

What is organ donation?

40 Organ donation is where a person offers their organs for transplant. Their organs are given to someone who has damaged organs that need to be replaced. An organ transplant may save a person's life, or it may significantly improve their health and quality of life.

The need for donors

In 2009, 3,700 organ transplants were carried out in the UK. However, there are always significantly more people waiting to have an organ transplant than there are suitable donors.

45 For example, at the end of March 2010, 8,000 people were waiting for an organ transplant. There is a particular need for more people of African, African-Caribbean and south Asian ethnicities to join the Organ Donor Register. This is because donation rates among these ethnic groups are low. Black people are three times more likely to develop kidney failure than the general population, and the need for donated organs in Asian communities is three to four
50 times higher than it is in the general population.

Most people who are waiting for a donated organ need to have a kidney, heart, lung or liver transplant. One donor can help several people. This is because a single donor is able to donate a number of organs – called multi-organ donation. The following table shows the number of organs donated in selected UK hospitals in 2010.

55 **Table 1** Number of organs donated in selected UK hospitals in 2010

Donating Hospital	Kidney	Heart	Lung	Liver	Pancreas
A	14	0	0	7	2
B	4	1	1	2	2
C	4	0	0	3	1
D	8	3	1	1	0
E	12	2	2	6	4
F	8	0	0	3	2
G	4	0	3	2	2
H	6	0	0	3	1

How to donate

60 The NHS Organ Donor Register is a national, confidential database that holds the details of more than 17 million people who want to donate their organs after their death. The register can be accessed by healthcare professionals to find out whether an individual has registered to be an organ donor.

Even though there are a significant number of people on the register, most people will not die in circumstances that will allow them to donate their organs. It is, therefore, important that as many people as possible join the register.

Checking for a match

65 When an organ becomes available for donation, it is checked to make sure that it is healthy. The blood and tissue type of both donor and recipient are also checked to ensure that they are compatible. The better the match, the greater the chance of a successful outcome.

70 People from the same ethnic group are more likely to be a close match. Those with rare tissue types may only be able to accept an organ from someone of the same ethnic origin. This is why it is so important that people from all ethnic backgrounds register to donate their organs.

Types of donation

There are three different ways of donating an organ. These are known as:

- donation after brain stem death
- donation after cardiac death
- 75 • live organ donation.

Donation after brain stem death

Most organ donations are from brain stem dead donors. This is where the donor has been diagnosed with brain stem death following a severe brain injury, and the circulation continues to be supported by artificial ventilation until the donated organs have been removed.

80 Heartbeating donations have a high success rate because the organs are supported by oxygenated blood until they are removed from the body of the donor.

Donation after cardiac death

85 Organs and tissue can also be donated from non-heartbeating donors. In the UK, almost all donors of this type are people who have died in intensive care from severe brain injuries, but who are not quite brain stem dead.

In such cases, the donation must occur within a few minutes of the heart stopping because, otherwise, the organs will be damaged by the lack of oxygenated blood and it will not be possible for them to be transplanted.

Live organ donation

90 A live organ donation usually involves one family member donating an organ to another family member. The relative is usually blood-related, most commonly a parent, although it could be a partner.

Following changes in the law, it is now possible to be an altruistic donor. Altruistic donors are unrelated to the patient but become donors as an act of personal generosity. Kidney donations
95 are often made from living donors as a healthy person can lead a normal life with only one working kidney.

When organ donation is used

The organs that can be donated are shown on the following diagram.

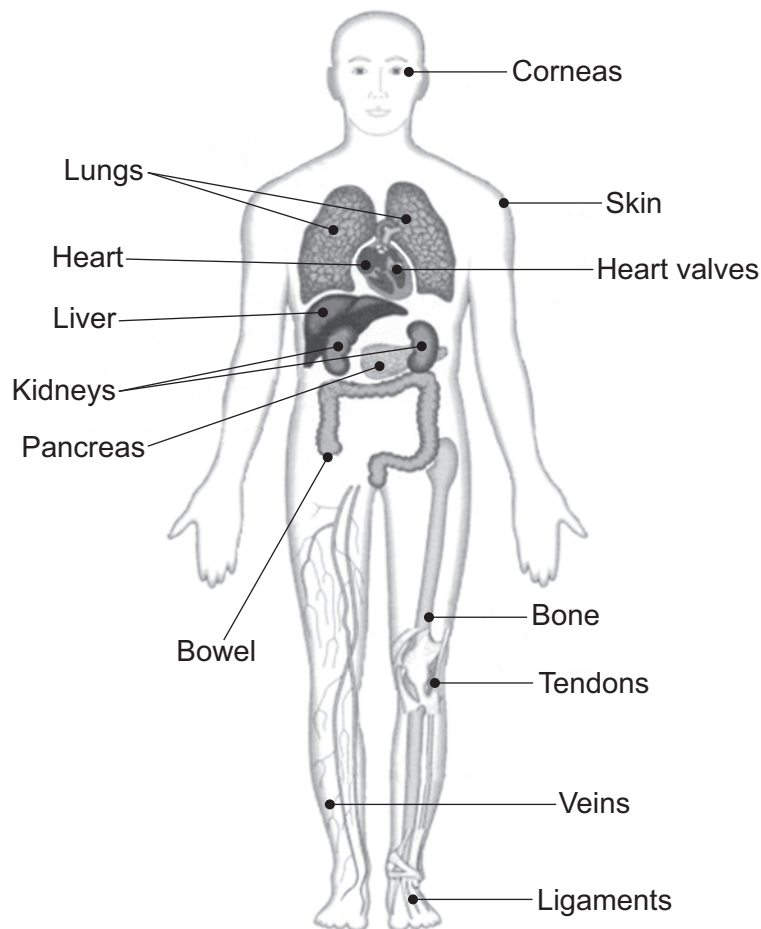


Figure 1 Diagram showing the organs/tissues that can be transplanted

Kidneys

- 100 A kidney can provide a better quality of life to someone who has end stage renal failure. Renal failure is where the kidneys stop working properly.

Kidney transplants give better long-term survival rates and quality of life than dialysis (where some of the kidney's functions are artificially replaced). Kidneys that are used for transplant can come from a living person or from someone who has died.

105 Liver

A liver transplant is often considered for people with end stage liver disease. In around 85% of cases, transplanted livers still function well a year after surgery.

Heart

- 110 Most heart transplants are carried out on people with severe heart failure, which is caused by coronary heart disease or cardiomyopathy (diseased heart muscles), who can no longer be helped by medication or other types of surgery. The survival rate after one year of having a heart transplant is approximately 85%.

Lungs

- 115 Lungs can be damaged by illnesses, such as cystic fibrosis (where the lungs become clogged with thick, sticky mucus), or respiratory conditions, such as chronic obstructive pulmonary disease (COPD), which are often the result of smoking.

Patients are considered for lung transplantation when their lung function cannot be significantly improved by medical therapy or surgery. Lung and heart-lung transplants have a 70% success rate one year after surgery.

120 Small bowel

A small bowel transplant is usually recommended if there is not enough bowel left to absorb nutrition (short bowel syndrome), and when the patient is having difficulty with total parenteral nutrition (TPN). TPN is where nutrition is given intravenously (through a vein).

- 125 Small bowel transplants are often performed at the same time as a liver and pancreas transplant. This is called a multi-visceral transplant.

Pancreas

A successful pancreas transplant is the only treatment that can restore complete insulin independence and blood sugar levels in patients with type 1 diabetes.

- 130 Data illustrating the numbers of donors, transplants and patients for the most commonly donated organs is shown in charts 1 to 4.

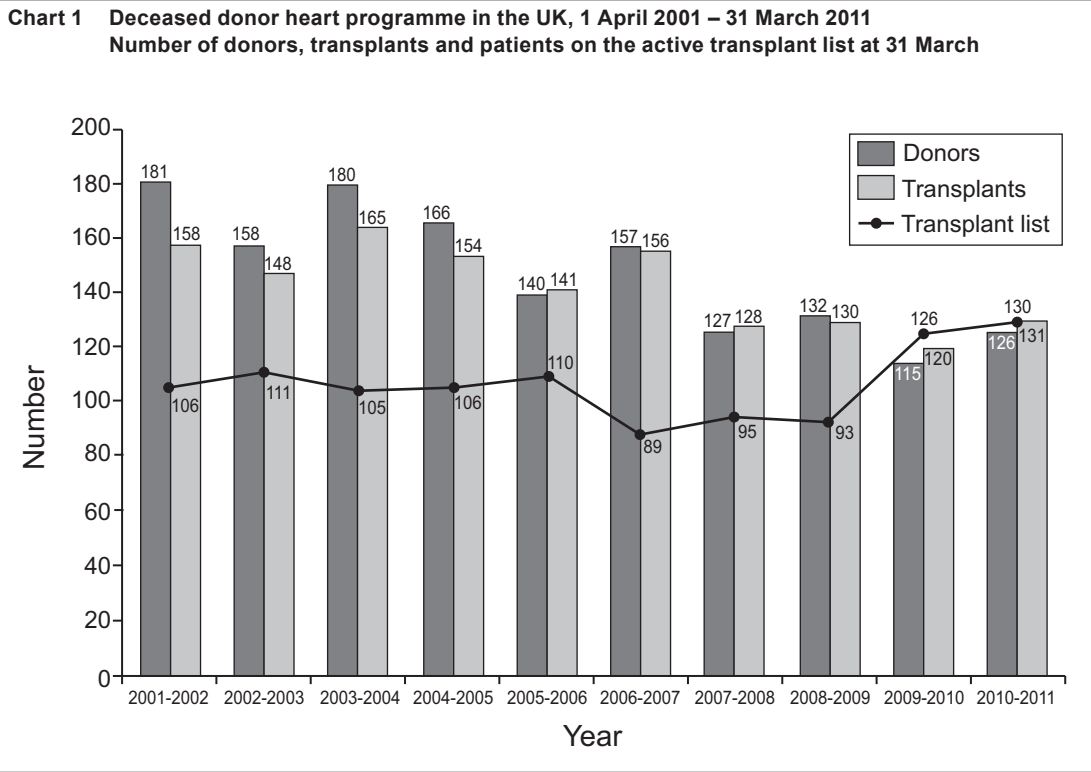


Chart 1

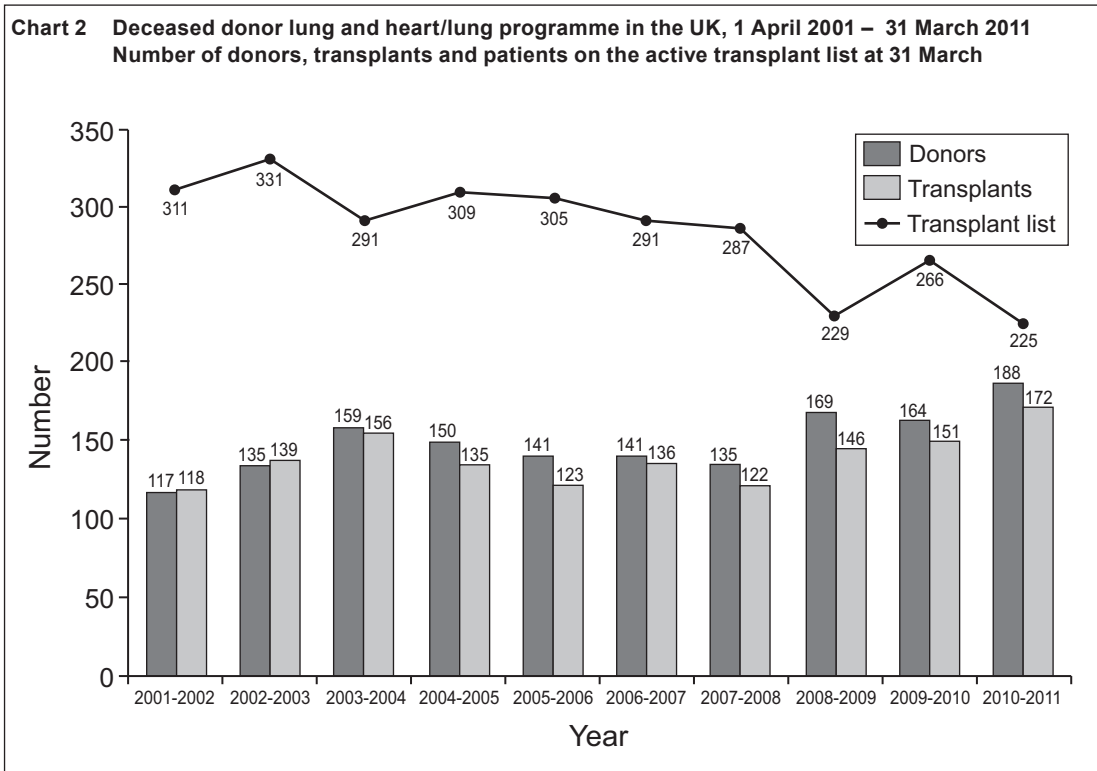


Chart 2

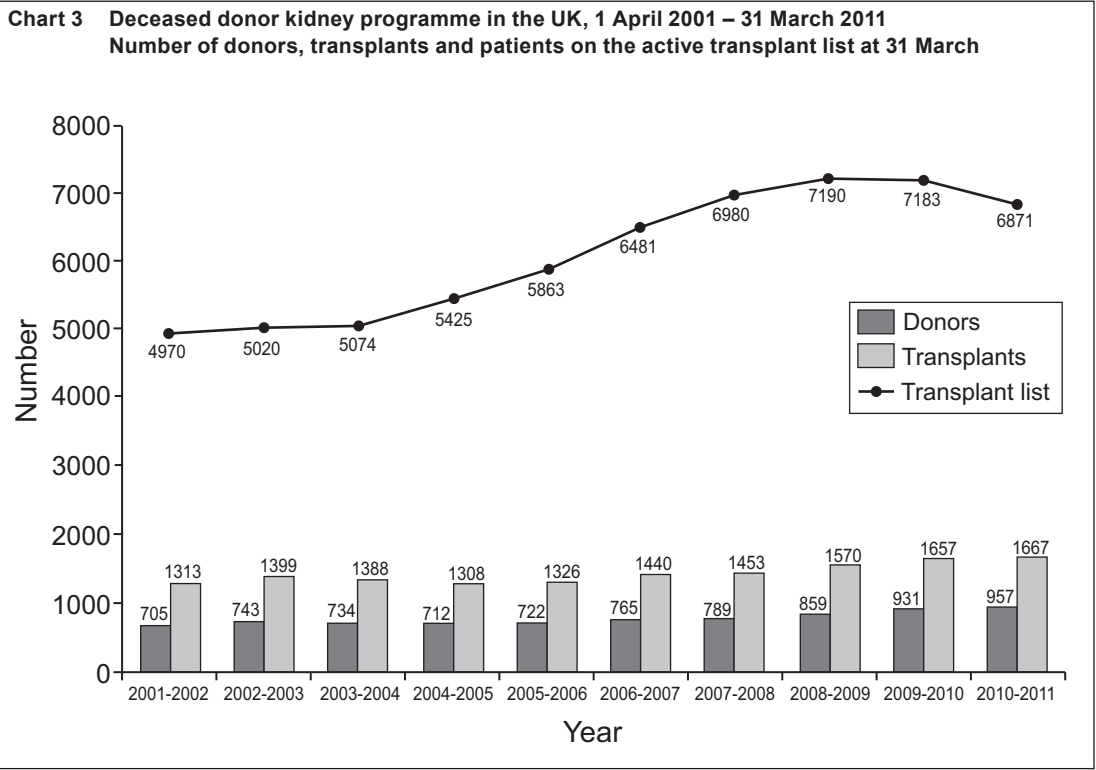


Chart 3

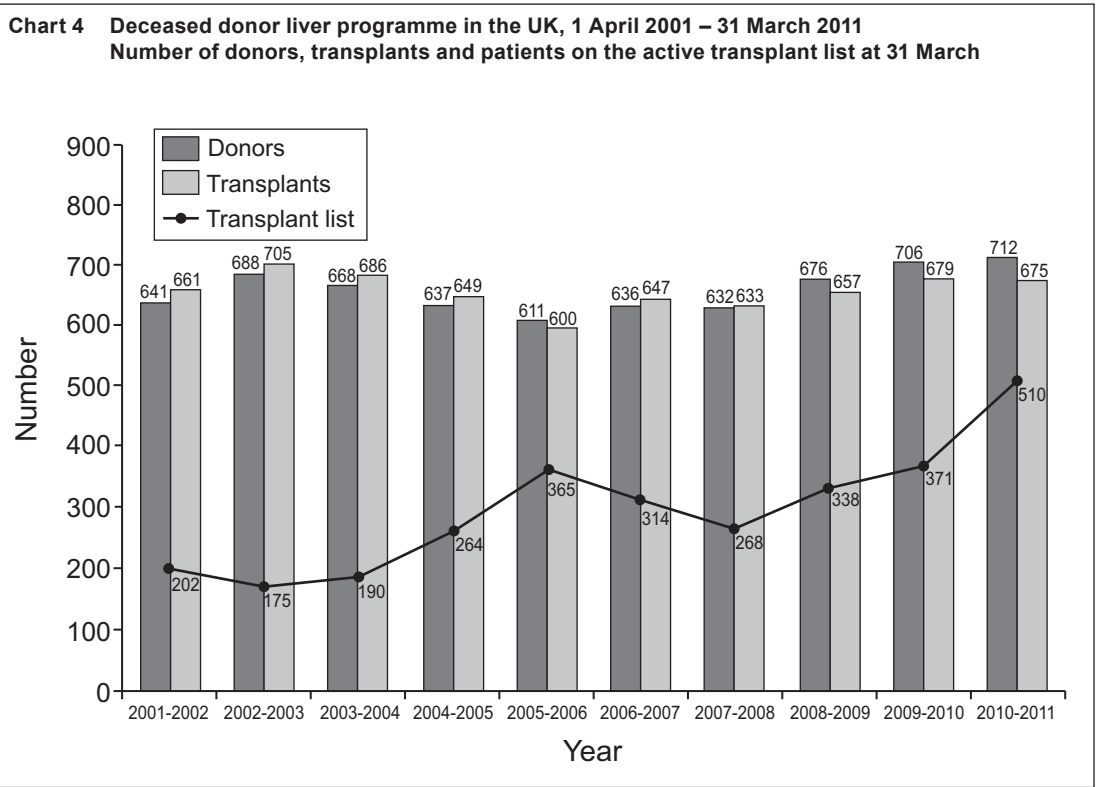


Chart 4

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Living organ donations

Kidneys are the most common organ to be donated by a living person. This is because it is possible for a healthy person to lead a completely normal life with only one working kidney. Nearly one in three of all kidney donations are from living donors.

- 135 It is also possible for part of a liver to be transplanted, and in some circumstances it may also be possible to donate a segment of lung. In a very small number of cases, part of the small bowel has also been transplanted.

The advantage of a living donor kidney transplant is that kidneys from a living donor last longer than those that are donated from someone who has died. Survival rates are also increased for
140 people who receive kidneys from live donors as opposed to donors who have died.

Success rates

Research has shown that in people who receive a kidney from someone who has died:

- 77% of kidneys will still be working at 5 years
- 58% of kidneys will still be working at 10 years.

145 However, in kidney transplants where the kidney is donated from a living donor:

- 84% of kidneys will still be working at 5 years
- 66% of kidneys will still be working at 10 years.

Survival rates

The survival rates of patients who receive kidney transplants from live donors are as follows:

- 150
- 94% will still be alive 5 years after the transplant
 - 85% will still be alive 10 years after the transplant.

For those who receive kidney transplants from donors who have died:

- 85% will still be alive five years after the transplant
- 61% will still be alive 10 years after the transplant.

155 Regulations and assessment

The Human Tissue Act 2004 and the Human Tissue (Scotland) Act 2006 provide the legal background for living donation in the UK. It is regulated by the Human Tissue Authority (HTA).

The HTA consists of 12 members, including 11 members from medical and scientific backgrounds, who are appointed by the Secretary of State for Health. The HTA's role in living donation is to
160 ensure that:

- donors are not put under pressure to donate an organ
- no payment is made for the donation (paying for donated organs is illegal in the UK).

After the organ donor and the recipient of the donation have been assessed by the transplant team, an independent assessor from the HTA will assess the donor. They will make sure that all
165 the legal requirements for the donation have been met.

The donation process

170 If appropriate, brain stem death testing is carried out by hospital staff to confirm that the patient is dead. Alternatively, a joint decision may be made by medical staff, nursing staff and the patient's relatives that, although brain stem death has not occurred, the prospect of survival is so low that it is not helpful to continue with artificial ventilation.

The organ donor register will be checked and if the patient is found to be on the register, the local specialist nurse for organ donation is contacted. If the patient is on the donor register, the specialist nurse will speak to the family about the patient's wishes.

175 If the family agrees to organ donation, the specialist nurse must ensure that medical tests are carried out, such as blood group and tissue type matching. They also look at the donor's medical history and may ask the family some questions about them. This will help to confirm whether or not the organ donation can take place.

Conditions that rule out organ donation

180 There are only two medical conditions that always prevent someone from donating an organ. These are:

- HIV, which is a virus that attacks the immune system (the body's natural defence against illness and infection) and is spread through the exchange of infected bodily fluids, such as blood.
- 185 • Creutzfeldt-Jakob Disease (CJD), which is a rare condition that affects the nervous system, causing brain damage. Patients who are suspected of having CJD are also prevented from donating organs.

190 All patients who are waiting for transplants are registered on the National Transplant Database at NHS Blood and Transplant. This is a database that holds records of every person in the UK who is waiting to receive an organ transplant. When organs from a donor become available, a computer search is carried out to find the most suitable recipients.

A team of specialist surgeons is called to the donor's hospital to carry out the surgery to remove and preserve the organs for transport to the transplant unit. Timing is crucial because certain organs need to be transplanted within four to six hours.

195 During the operation, the surgeon will make a final decision about whether the organs are healthy and suitable to be transplanted. If all is well, the organ is received at the transplant unit and transplanted immediately. After the transplant has been completed, the recovery process and a new life for the transplant recipient can begin.

Risks associated with organ donation

There are some risks associated with organ donation. These are outlined below.

200 **Virus transmission**

To reduce the risk of diseases and viruses being transmitted from an organ donor to a recipient, all potential organ donors have a sample of their blood taken. The blood is tested for:

- **HIV** (see page 11)
- **Hepatitis**, which is a virus that causes inflammation (swelling) of the liver. Hepatitis
205 can be passed on through bodily fluids, such as semen, blood and saliva.

Immunosuppressant medication

Most people do not experience any physical problems after receiving a transplanted organ. However, after the operation the recipient will have to take immunosuppressant medication to prevent the body rejecting the new organ. Without this medication, the body will try to reject the
210 donated organ.

Immunosuppressants work by suppressing (controlling) the immune system, which allows the body to accept the donated organ. However, the recipient will need to take immunosuppressants for the rest of his or her life. Immunosuppressants have side effects, including:

- an increased risk of developing some types of cancer
- an increased risk of developing infections.

Following an organ donation, the side effects that are experienced will depend on the type of immunosuppressant medication and the dosage that is required. The potential side effects of immunosuppressants should be discussed with the surgeon or transplant team.

Other risks

220 The donor may also experience prolonged wound pain after the donation operation. Depression and anxiety are also common. There is a risk of a number of long-term complications relating to specific donated organs.

There are ethical questions regarding live organ donation. If more people donated organs after their death it would not be necessary to use live donors. There are also concerns about the
225 possibility of pressure being put on people to donate to a family member.

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SECTION A

Answer all questions.

1. State **three** different ways of donating an organ. [1]

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.....

.....

2. Suggest **one** benefit and **one** problem with changing the law on organ donation in Wales to an opt-out system. [2]

Benefit

.....

Problem

.....

3. (a) Explain why organ donation is necessary. [1]

.....

.....

- (b) State **two** disadvantages of organ donation to the person **receiving** the organ. [2]

1.

.....

2.

.....

4. (a) State **two** reasons why living donor kidney transplants are preferable to donations from someone who has died. [2]

1.

.....

2.

.....

(b) Suggest **one** reason why payment for donated organs is illegal in the UK. [1]

.....

5. Please refer to the charts on **pages 8 and 9** to answer this question.

(a) State the name of **one** organ for which the number of donors appears to meet demand for organs. [1]

.....

(b) Suggest **one** reason why there are still patients on the transplant list although the supply of donated organs meets the demand. [1]

.....

.....

6. Please refer to **Table 1** on **page 4** to answer this question

(a) (i) Name the least donated organ in the hospitals in **Table 1**. [1]

.....

(ii) Suggest **one** reason why this is the case. [1]

.....

.....

(b) Suggest **two** reasons why kidneys are the most donated organs. [2]

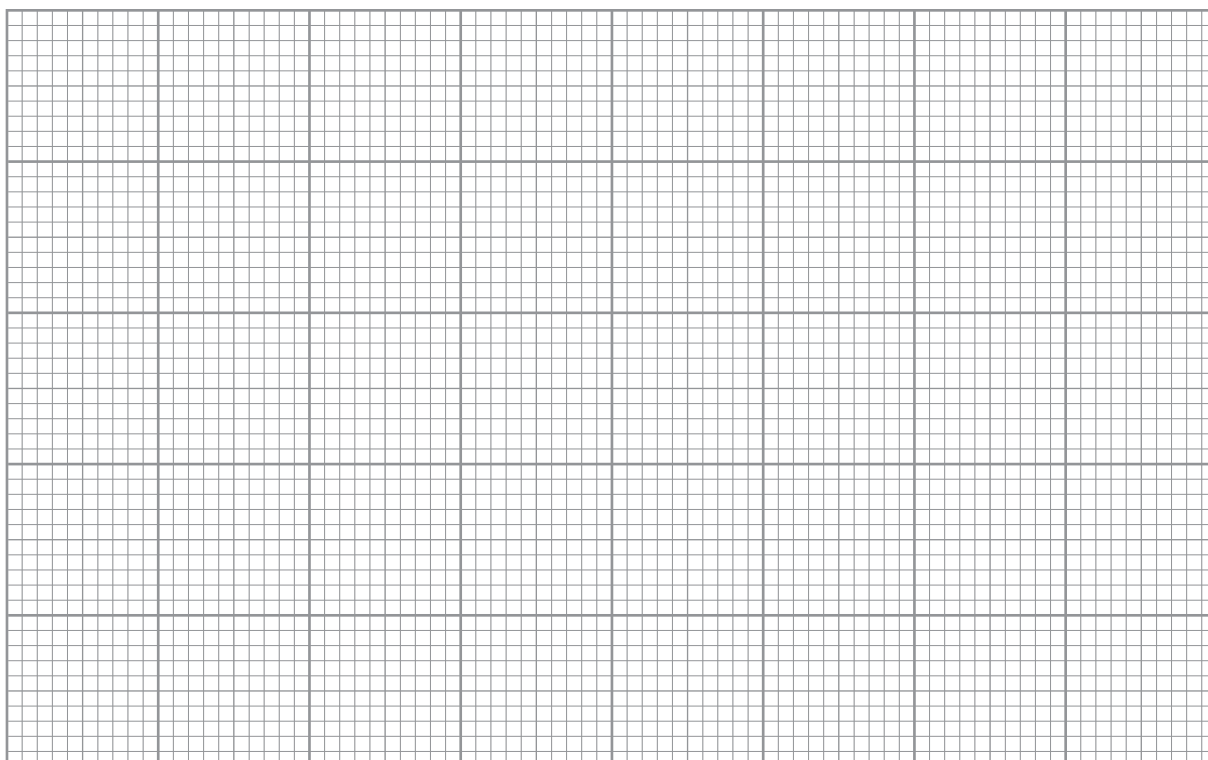
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7. "Survival rates are also increased for people who receive kidneys from live donors as opposed to donors who have died." (**page 10, lines 139 to 140**).

(i) Use relevant data from **page 10** to construct a table to show the **survival** rates of patients who receive kidney transplants. [2]

(ii) Use your table to construct a suitable chart showing the **survival** rates of people who have kidney transplants. [3]



8. Explain why the tissue and blood type of the donor and recipient are checked before a transplant is carried out. [1]

.....

9. “Heartbeating donations have a high success rate because the organs are supported by oxygenated blood until they are removed from the body of the donor” (page 5, lines 80-81)

(a) Describe how the blood in the capillaries around the alveoli is oxygenated. [3]

.....

.....

.....

.....

.....

(b) State the role of the following structures in the cardiac cycle: [3]

(i) *Vena cava*:

.....

(ii) *Tricuspid Valve*:

.....

(iii) *Bundle of His*:

.....

10. “Most heart transplants are carried out on people with severe heart failure, which is caused by coronary heart disease or cardiomyopathy” (page 7, lines 109 to 110)

(a) State what is meant by the term *coronary heart disease*. [2]

.....

.....

(b) Suggest **two** possible causes of coronary heart disease. [2]

.....

.....

11. State **two** medical conditions that prevent donation of organs. [1]

.....

SECTION B*Answer all questions.*

12. The table below shows some physiological measurements made on a 20 year old athlete at rest and at the end of a period of strenuous exercise.

Physiological Measurement	At Rest	Immediately after Strenuous Exercise
Breathing rate (breaths min^{-1})	12
Cardiac output ($\text{dm}^3\text{min}^{-1}$)	5	25
Heart rate (beats min^{-1})	70	190
Stroke volume (cm^3)	71	132
Oxygen consumption ($\text{cm}^3\text{min}^{-1}$)	250	2500
Systolic pressure (mmHg)	180

- (a) Using the data sheet on **page 32** as a reference, complete the table by estimating the following measurements:
- (i) breathing rate at the end of strenuous exercise. [1]
- (ii) systolic blood pressure at rest. [1]
- (b) Calculate the percentage increase in stroke volume after strenuous exercise. [2]

..... %

(c) Explain why the changes shown in the table opposite occur during exercise. [4]

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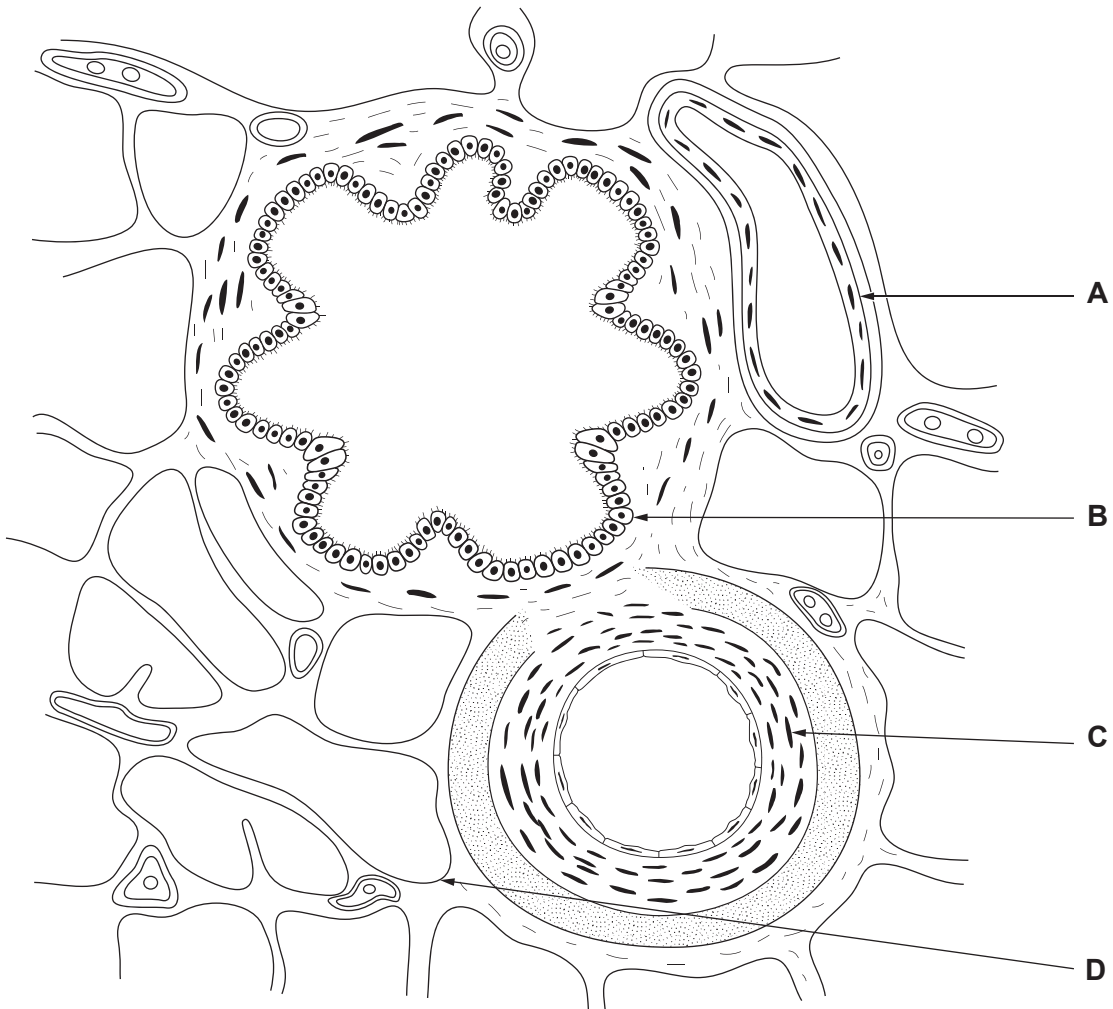
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(d) Suggest why regular exercise is beneficial for a person's heart. [1]

.....

.....

13. The following diagram shows a cross section of the lung tissue.



(a) State the names of structures **A**, **B** and **C**.

[3]

D is named for you.

A **B**

C **D** *alveolus*

(b) Describe **two** adaptations of the alveolus that make it suitable for its function. [2]

.....

.....

(c) State the name of the cells lining structure **C** and describe their function. [2]

Name

Function

.....

(d) (i) Describe how the structure of the alveoli would differ in a person suffering from emphysema. [2]

.....

.....

.....

(ii) What effect would these changes have on gas exchange? [1]

.....

(e) The peak flow of a person suffering from emphysema is likely to be different to that of a healthy person.

(i) Describe how a peak flow meter is used to measure peak flow rate. [2]

.....

.....

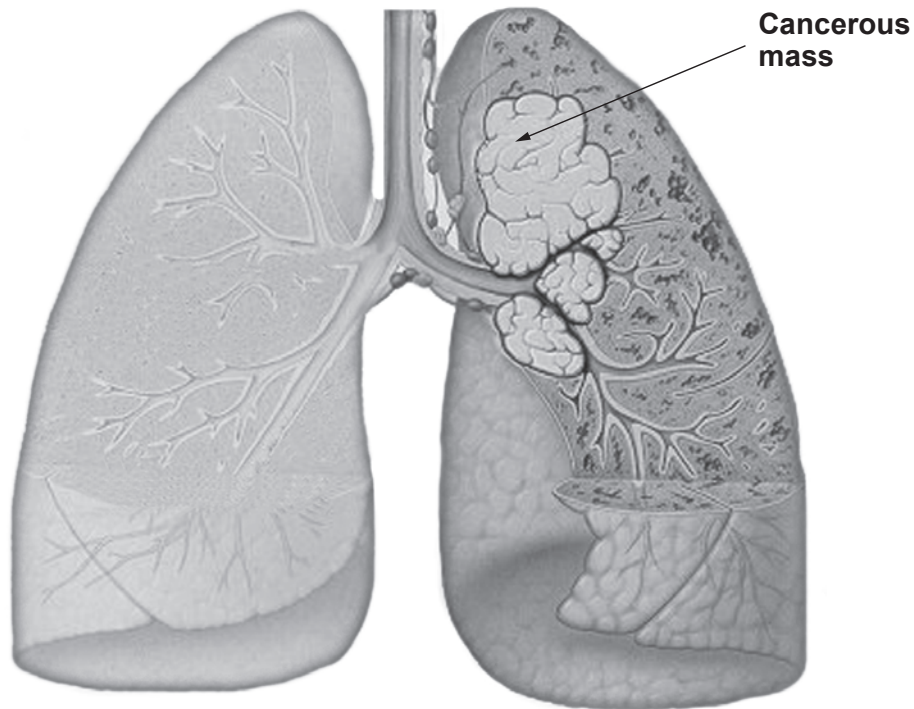
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(ii) State the expected effect of emphysema on peak flow rate. [1]

.....

14. The image below shows lungs that are affected by cancer.



- (a) The cancerous mass reduces the lung space available for gas exchange. **Suggest two** symptoms of lung cancer. [2]

.....

.....

- (b) Endobronchial ultrasound is a new technique for diagnosing lung cancer. MRI is rarely used to image lung cancer.

- (i) Name **two** other medical imaging techniques that could be used to discover and locate tumours in the lungs. [2]

.....

.....

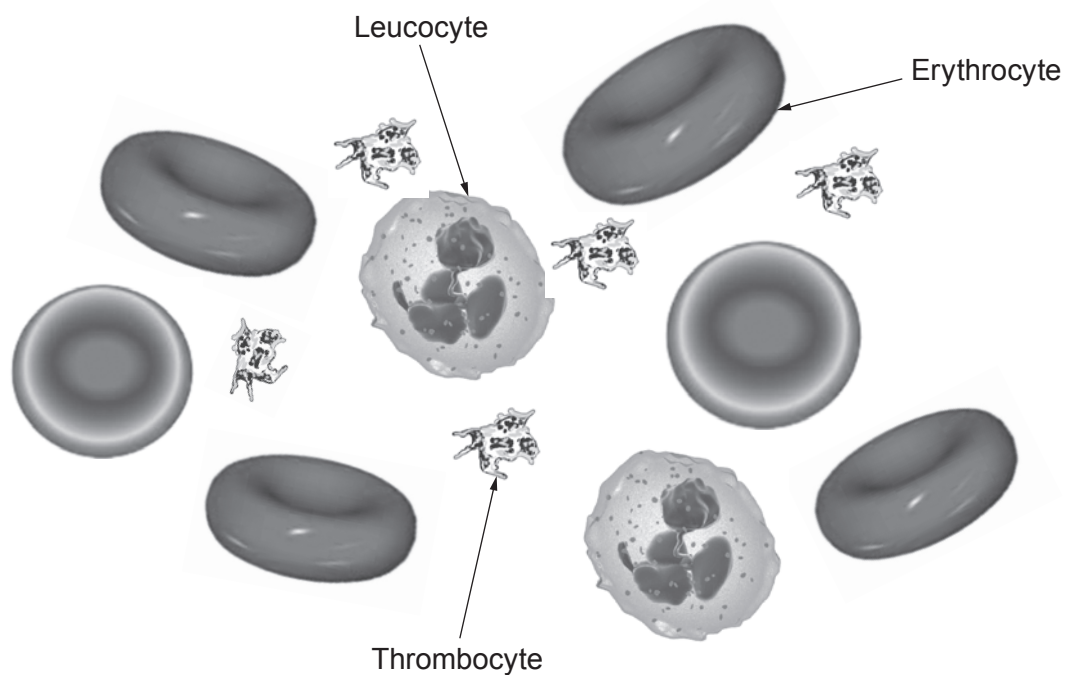
- (ii) Give **one** advantage of using ultrasound over the techniques named in part (i) to detect lung cancer. [1]

.....

.....

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15. A Phlebotomist was studying the composition of a patient's blood.



(a) Describe how erythrocytes are adapted for their function. [2]

.....

.....

.....

(b) The diagram shows the presence of many thrombocytes. State the function of the thrombocytes. [1]

.....

(c) What component of the blood is not labelled in the diagram? State **two** functions of this component. [3]

.....

.....

.....

.....

- (d) (i) What piece of equipment would measure the number of blood cells in a blood sample? [1]

-
- (ii) Outline a rule for counting blood cells using this equipment. [2]

.....

.....

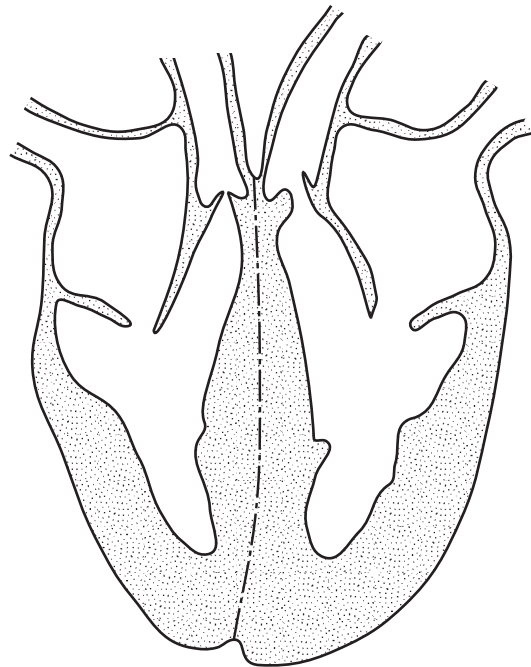
Examiner
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16. Catrin was studying the electrical activity of the heart as part of her Applied Science course. She learnt that the heart muscle was myogenic and that the electrical excitation spread in a particular route, to ensure that the chambers contract in the correct sequence.

(a) State what is meant by the term *myogenic*.

[1]

(b) (i) Catrin studied the role of the Atrio-Ventricular Node, Purkinje (Purkyne) tissue and Sino-Atrial Node. On the diagram below, show the position of these **three** structures. [3]



(ii) On the diagram above, use arrows to show the path of the electrical impulse across the heart. [3]

- (c) The atrio-ventricular septum is a thin layer of tissue between the outer walls of the atria and ventricles. Explain the role of the atrio-ventricular septum. [2]

.....

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.....

.....

- (d) Name the equipment used to determine the electrical activity of the heart. [1]

.....

- (e) In Britain, about 10000 people a year are fitted with an artificial pacemaker to treat an abnormally slow heartbeat.



An artificial pacemaker

- (i) What is the medical term given to a heart beat of less than 60 beats per minute? [1]

.....

- (ii) What region mentioned in part (b) is mimicked by an artificial pacemaker? [1]

.....

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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
BREATHING		
Rate	12 – 15 breaths per minute	12 – 15 breaths per minute
Tidal volume	400 – 500 cm ³	400 – 500 cm ³
Vital Capacity	4.8 dm ³	3.1 dm ³
Peak Flow	400 – 600 dm ³ min ⁻¹	400 – 600 dm ³ min ⁻¹
BLOOD PRESSURE		
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 ⁻³	4.5 – 6.1 mmol dm ⁻³
Sodium ions	133 – 147 mmol dm ⁻³	133 – 147 mmol dm ⁻³
Potassium ions	3.5 – 5.0 mmol dm ⁻³	3.5 – 5.0 mmol dm ⁻³
Calcium ions	1.15 – 1.29 mmol dm ⁻³	1.15 – 1.29 mmol dm ⁻³
Zinc ions	10 – 17 µmol dm ⁻³	10 – 17 µmol dm ⁻³
RED BLOOD CELLS		
Haemoglobin	140 – 180 g dm ⁻³	115 – 160 g dm ⁻³
Red Cell count	4.5 – 6.5 × 10 ¹² dm ⁻³	3.8 – 5.8 × 10 ¹² dm ⁻³
WHITE BLOOD CELL COUNT		
	4 – 11 × 10 ⁹ dm ⁻³	4 – 11 × 10 ⁹ dm ⁻³
PLATELET COUNT		
	150 – 400 × 10 ⁹ dm ⁻³	150 – 400 × 10 ⁹ dm ⁻³



GCE AS/A level

1661/01A

**APPLIED SCIENCE
UNIT 1**

**Pre-release Article for Examination in
May 2014**

1661
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://www.bbc.co.uk/news/uk-wales-18458873>

<http://www.nhs.uk/conditions/organ-donation/Pages/Introduction.aspx>

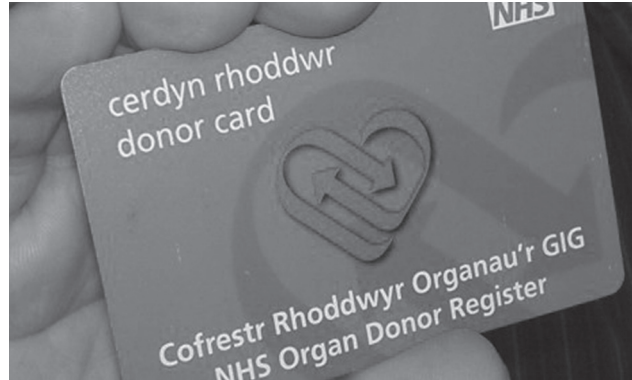
No recall or terminology is required over and above that in the specification.

Students 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.

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'Talk to families'

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The above article is adapted from a report published on the BBC website on 18 June 2012.

What is organ donation?

40 Organ donation is where a person offers their organs for transplant. Their organs are given to someone who has damaged organs that need to be replaced. An organ transplant may save a person's life, or it may significantly improve their health and quality of life.

The need for donors

In 2009, 3,700 organ transplants were carried out in the UK. However, there are always significantly more people waiting to have an organ transplant than there are suitable donors.

45 For example, at the end of March 2010, 8,000 people were waiting for an organ transplant. There is a particular need for more people of African, African-Caribbean and south Asian ethnicities to join the Organ Donor Register. This is because donation rates among these ethnic groups are low. Black people are three times more likely to develop kidney failure than the general population, and the need for donated organs in Asian communities is three to four
50 times higher than it is in the general population.

Most people who are waiting for a donated organ need to have a kidney, heart, lung or liver transplant. One donor can help several people. This is because a single donor is able to donate a number of organs – called multi-organ donation. The following table shows the number of organs donated in selected UK hospitals in 2010.

55 **Table 1** Number of organs donated in selected UK hospitals in 2010

Donating Hospital	Kidney	Heart	Lung	Liver	Pancreas
A	14	0	0	7	2
B	4	1	1	2	2
C	4	0	0	3	1
D	8	3	1	1	0
E	12	2	2	6	4
F	8	0	0	3	2
G	4	0	3	2	2
H	6	0	0	3	1

How to donate

The NHS Organ Donor Register is a national, confidential database that holds the details of more than 17 million people who want to donate their organs after their death. The register can be accessed by healthcare professionals to find out whether an individual has registered to be an organ donor.

Even though there are a significant number of people on the register, most people will not die in circumstances that will allow them to donate their organs. It is, therefore, important that as many people as possible join the register.

Checking for a match

When an organ becomes available for donation, it is checked to make sure that it is healthy. The blood and tissue type of both donor and recipient are also checked to ensure that they are compatible. The better the match, the greater the chance of a successful outcome.

People from the same ethnic group are more likely to be a close match. Those with rare tissue types may only be able to accept an organ from someone of the same ethnic origin. This is why it is so important that people from all ethnic backgrounds register to donate their organs.

Types of donation

There are three different ways of donating an organ. These are known as:

- donation after brain stem death
- donation after cardiac death
- live organ donation.

Donation after brain stem death

Most organ donations are from brain stem dead donors. This is where the donor has been diagnosed with brain stem death following a severe brain injury, and the circulation continues to be supported by artificial ventilation until the donated organs have been removed.

Heartbeating donations have a high success rate because the organs are supported by oxygenated blood until they are removed from the body of the donor.

Donation after cardiac death

Organs and tissue can also be donated from non-heartbeating donors. In the UK, almost all donors of this type are people who have died in intensive care from severe brain injuries, but who are not quite brain stem dead.

In such cases, the donation must occur within a few minutes of the heart stopping because, otherwise, the organs will be damaged by the lack of oxygenated blood and it will not be possible for them to be transplanted.

Live organ donation

90 A live organ donation usually involves one family member donating an organ to another family member. The relative is usually blood-related, most commonly a parent, although it could be a partner.

Following changes in the law, it is now possible to be an altruistic donor. Altruistic donors are unrelated to the patient but become donors as an act of personal generosity. Kidney donations are often made from living donors as a healthy person can lead a normal life with only one working kidney.

When organ donation is used

The organs that can be donated are shown on the following diagram.

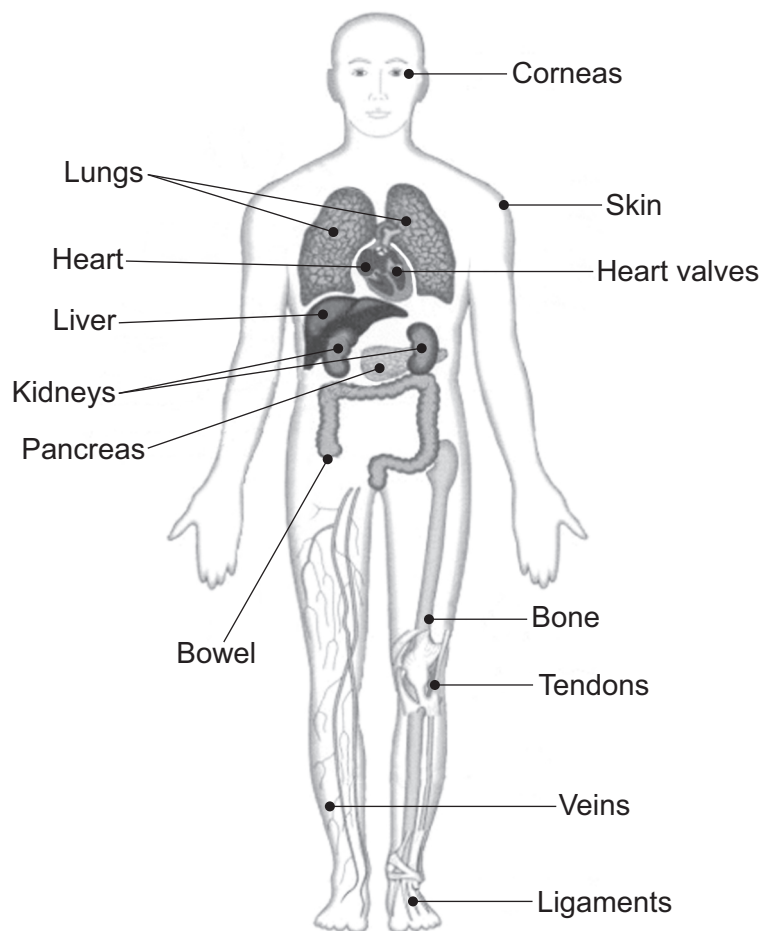


Figure 1 Diagram showing the organs/tissues that can be transplanted

Kidneys

- 100 A kidney can provide a better quality of life to someone who has end stage renal failure. Renal failure is where the kidneys stop working properly.

Kidney transplants give better long-term survival rates and quality of life than dialysis (where some of the kidney's functions are artificially replaced). Kidneys that are used for transplant can come from a living person or from someone who has died.

105 Liver

A liver transplant is often considered for people with end stage liver disease. In around 85% of cases, transplanted livers still function well a year after surgery.

Heart

- 110 Most heart transplants are carried out on people with severe heart failure, which is caused by coronary heart disease or cardiomyopathy (diseased heart muscles), who can no longer be helped by medication or other types of surgery. The survival rate after one year of having a heart transplant is approximately 85%.

Lungs

- 115 Lungs can be damaged by illnesses, such as cystic fibrosis (where the lungs become clogged with thick, sticky mucus), or respiratory conditions, such as chronic obstructive pulmonary disease (COPD), which are often the result of smoking.

Patients are considered for lung transplantation when their lung function cannot be significantly improved by medical therapy or surgery. Lung and heart-lung transplants have a 70% success rate one year after surgery.

120 Small bowel

A small bowel transplant is usually recommended if there is not enough bowel left to absorb nutrition (short bowel syndrome), and when the patient is having difficulty with total parenteral nutrition (TPN). TPN is where nutrition is given intravenously (through a vein).

- 125 Small bowel transplants are often performed at the same time as a liver and pancreas transplant. This is called a multi-visceral transplant.

Pancreas

A successful pancreas transplant is the only treatment that can restore complete insulin independence and blood sugar levels in patients with type 1 diabetes.

- 130 Data illustrating the numbers of donors, transplants and patients for the most commonly donated organs is shown in charts 1 to 4.

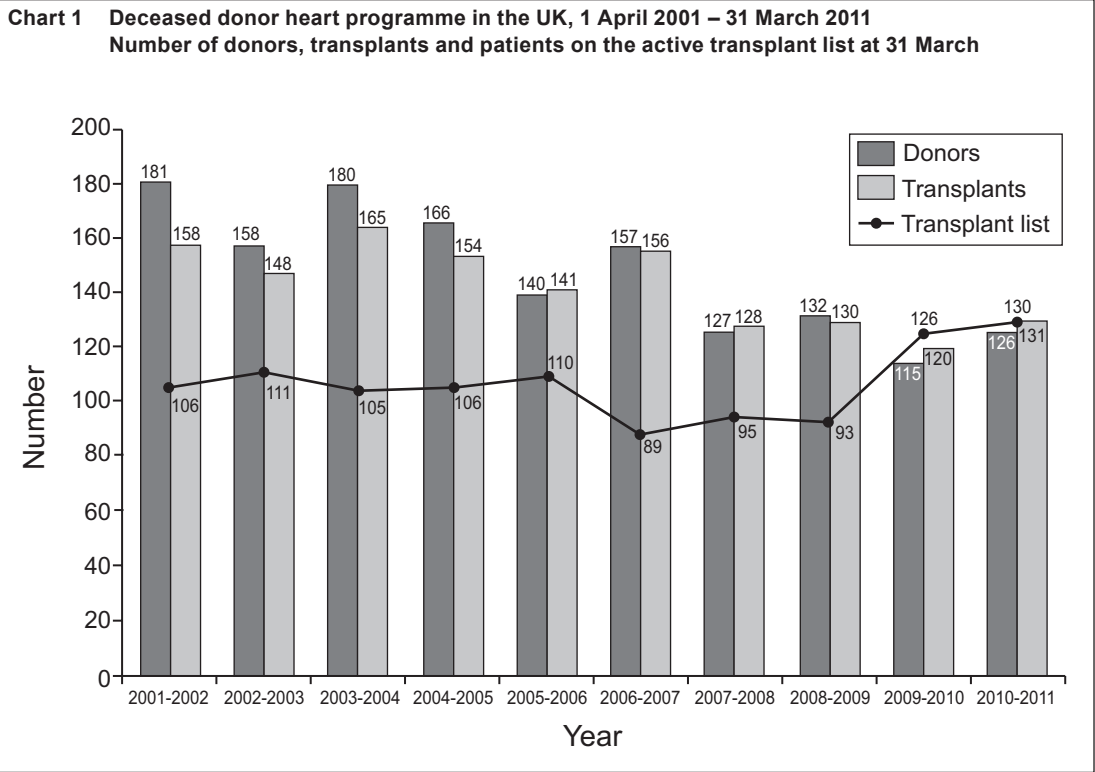


Chart 1

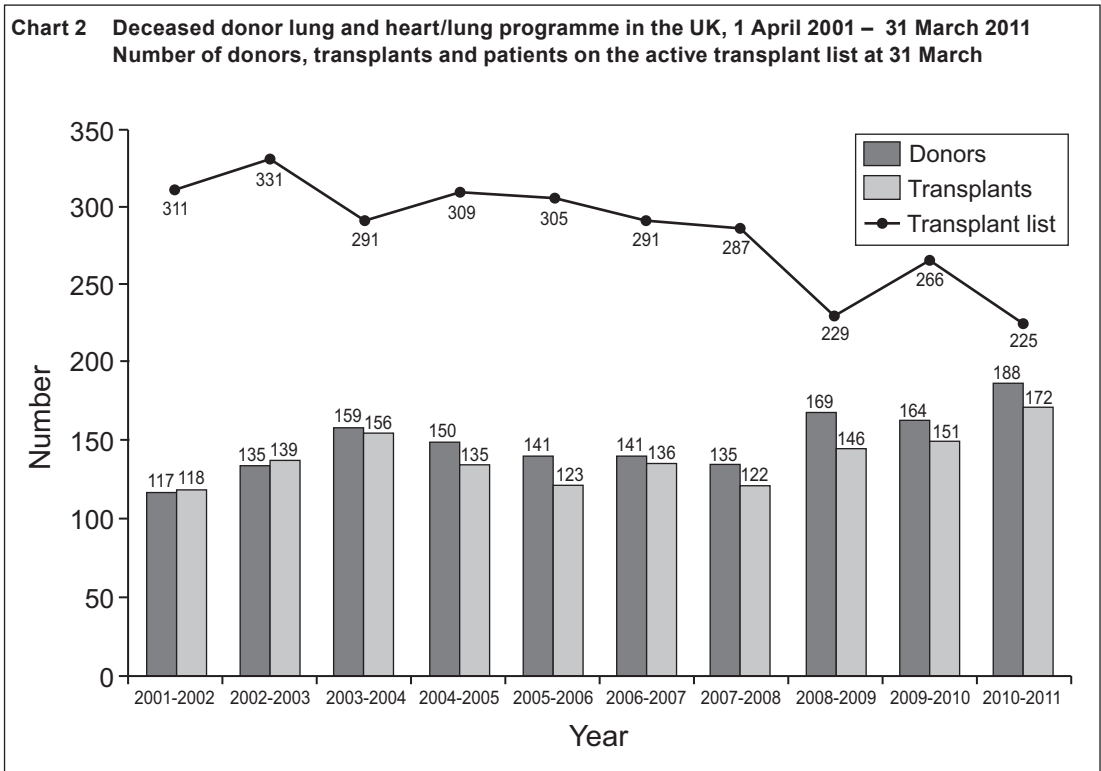


Chart 2

Chart 3 Deceased donor kidney programme in the UK, 1 April 2001 – 31 March 2011
Number of donors, transplants and patients on the active transplant list at 31 March

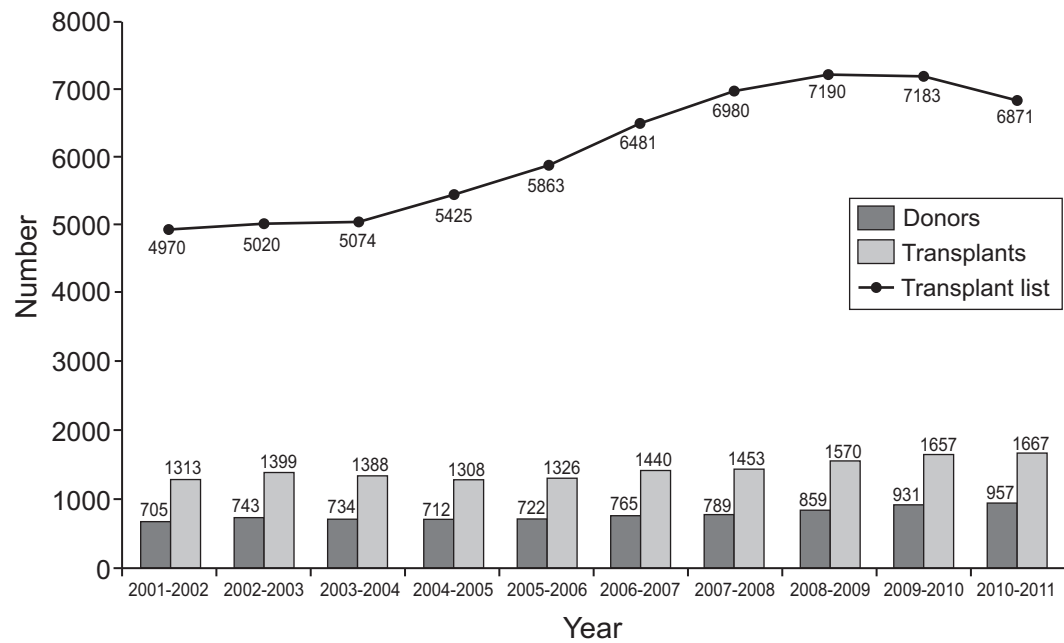


Chart 3

Chart 4 Deceased donor liver programme in the UK, 1 April 2001 – 31 March 2011
Number of donors, transplants and patients on the active transplant list at 31 March

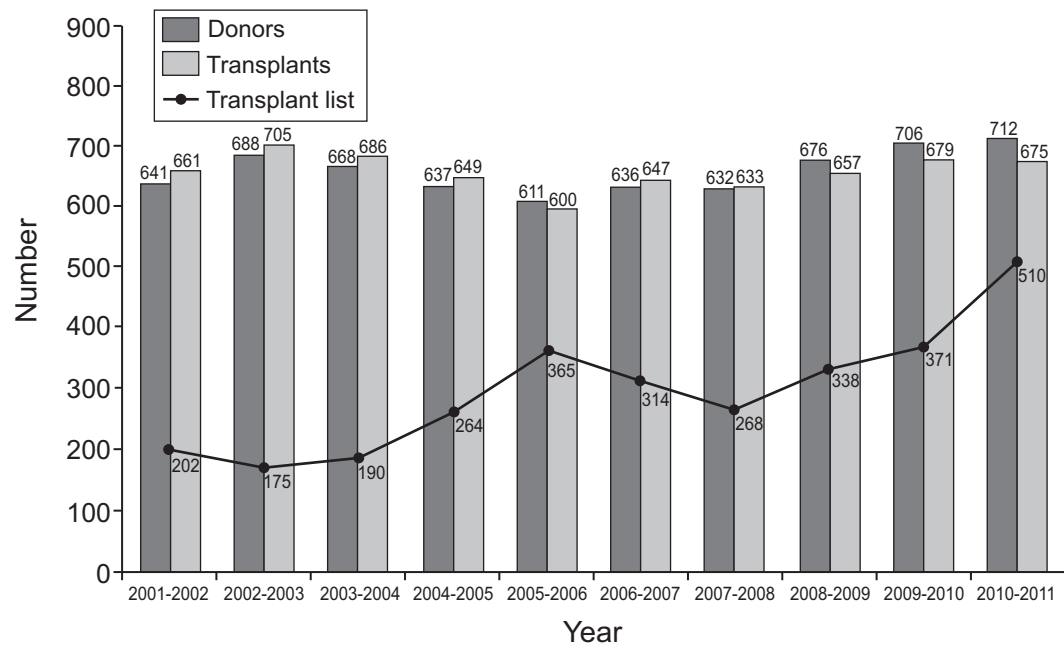


Chart 4

Living organ donations

Kidneys are the most common organ to be donated by a living person. This is because it is possible for a healthy person to lead a completely normal life with only one working kidney. Nearly one in three of all kidney donations are from living donors.

- 135 It is also possible for part of a liver to be transplanted, and in some circumstances it may also be possible to donate a segment of lung. In a very small number of cases, part of the small bowel has also been transplanted.

- 140 The advantage of a living donor kidney transplant is that kidneys from a living donor last longer than those that are donated from someone who has died. Survival rates are also increased for people who receive kidneys from live donors as opposed to donors who have died.

Success rates

Research has shown that in people who receive a kidney from someone who has died:

- 77% of kidneys will still be working at 5 years
- 58% of kidneys will still be working at 10 years.

- 145 However, in kidney transplants where the kidney is donated from a living donor:

- 84% of kidneys will still be working at 5 years
- 66% of kidneys will still be working at 10 years.

Survival rates

The survival rates of patients who receive kidney transplants from live donors are as follows:

- 150
- 94% will still be alive 5 years after the transplant
 - 85% will still be alive 10 years after the transplant.

For those who receive kidney transplants from donors who have died:

- 85% will still be alive five years after the transplant
- 61% will still be alive 10 years after the transplant.

155 Regulations and assessment

The Human Tissue Act 2004 and the Human Tissue (Scotland) Act 2006 provide the legal background for living donation in the UK. It is regulated by the Human Tissue Authority (HTA).

- 160 The HTA consists of 12 members, including 11 members from medical and scientific backgrounds, who are appointed by the Secretary of State for Health. The HTA's role in living donation is to ensure that:

- donors are not put under pressure to donate an organ
- no payment is made for the donation (paying for donated organs is illegal in the UK).

- 165 After the organ donor and the recipient of the donation have been assessed by the transplant team, an independent assessor from the HTA will assess the donor. They will make sure that all the legal requirements for the donation have been met.

The donation process

170 If appropriate, brain stem death testing is carried out by hospital staff to confirm that the patient is dead. Alternatively, a joint decision may be made by medical staff, nursing staff and the patient's relatives that, although brain stem death has not occurred, the prospect of survival is so low that it is not helpful to continue with artificial ventilation.

The organ donor register will be checked and if the patient is found to be on the register, the local specialist nurse for organ donation is contacted. If the patient is on the donor register, the specialist nurse will speak to the family about the patient's wishes.

175 If the family agrees to organ donation, the specialist nurse must ensure that medical tests are carried out, such as blood group and tissue type matching. They also look at the donor's medical history and may ask the family some questions about them. This will help to confirm whether or not the organ donation can take place.

Conditions that rule out organ donation

180 There are only two medical conditions that always prevent someone from donating an organ. These are:

- HIV, which is a virus that attacks the immune system (the body's natural defence against illness and infection) and is spread through the exchange of infected bodily fluids, such as blood.
- 185 • Creutzfeldt-Jakob Disease (CJD), which is a rare condition that affects the nervous system, causing brain damage. Patients who are suspected of having CJD are also prevented from donating organs.

190 All patients who are waiting for transplants are registered on the National Transplant Database at NHS Blood and Transplant. This is a database that holds records of every person in the UK who is waiting to receive an organ transplant. When organs from a donor become available, a computer search is carried out to find the most suitable recipients.

A team of specialist surgeons is called to the donor's hospital to carry out the surgery to remove and preserve the organs for transport to the transplant unit. Timing is crucial because certain organs need to be transplanted within four to six hours.

195 During the operation, the surgeon will make a final decision about whether the organs are healthy and suitable to be transplanted. If all is well, the organ is received at the transplant unit and transplanted immediately. After the transplant has been completed, the recovery process and a new life for the transplant recipient can begin.

Risks associated with organ donation

There are some risks associated with organ donation. These are outlined below.

200 **Virus transmission**

To reduce the risk of diseases and viruses being transmitted from an organ donor to a recipient, all potential organ donors have a sample of their blood taken. The blood is tested for:

- **HIV** (see page 11)
- **Hepatitis**, which is a virus that causes inflammation (swelling) of the liver. Hepatitis
205 can be passed on through bodily fluids, such as semen, blood and saliva.

Immunosuppressant medication

Most people do not experience any physical problems after receiving a transplanted organ. However, after the operation the recipient will have to take immunosuppressant medication to prevent the body rejecting the new organ. Without this medication, the body will try to reject
210 the donated organ.

Immunosuppressants work by suppressing (controlling) the immune system, which allows the body to accept the donated organ. However, the recipient will need to take immunosuppressants for the rest of his or her life. Immunosuppressants have side effects, including:

- an increased risk of developing some types of cancer
- an increased risk of developing infections.

Following an organ donation, the side effects that are experienced will depend on the type of immunosuppressant medication and the dosage that is required. The potential side effects of immunosuppressants should be discussed with the surgeon or transplant team.

Other risks

220 The donor may also experience prolonged wound pain after the donation operation. Depression and anxiety are also common. There is a risk of a number of long-term complications relating to specific donated organs.

There are ethical questions regarding live organ donation. If more people donated organs after their death it would not be necessary to use live donors. There are also concerns about the
225 possibility of pressure being put on people to donate to a family member.