1. Atrial fibrillation (AF) is a type of abnormal heart beat.

A health professional can detect AF by comparing the pulse of a patient with that of a person with a normal pulse.

(i) Describe how the health professional would manually measure the pulse **rate** of the patient.

---

[2]

(ii) A patient with AF may develop blood clots within the chambers of the heart.

Suggest why AF may cause blood clots in the chambers of the heart.

---

[1]

2. Approximately 1 in 12 adults in the UK suffer from asthma.

- Asthma can be a cause of respiratory arrest in adults.
- The diagnosis and monitoring of asthma can be done using a peak flow meter.
- The peak flow meter can measure the peak expiratory flow rate (PEFR) of a patient.

(i) Describe what is meant by the terms *respiratory arrest* and *peak expiratory flow rate.*

respiratory arrest _____

_____

peak expiratory flow rate _____

_____

[2]

(ii) Peak expiratory flow rate (PEFR) is one lung function measurement.

State one **other** lung function measurement that could be taken using a peak flow meter.

_____ **[1]**

(iii) Name the first aid procedure that may be carried out on an adult in respiratory arrest.

_____ **[1]**

(iv) Describe **one** way in which the procedure named in **(a)(iii)** would be different when carried out on a baby.

_____

_____

_____ **[1]**

3. Plasma LDH concentrations were used to diagnose and monitor heart attacks.

The concentration of other molecules within the plasma is now more commonly used. One of these molecules is cardiac troponin (troponin T).

(i) Describe the role of troponin T in cardiac muscle **cells** during diastole.

---

[2]

(ii) **Table 33.1** shows the results from an investigation comparing troponin T plasma concentrations in three different groups.

Group	Number of subjects	Concentration of plasma troponin T (μg dm^{-3})	
		Median	Interquartile range
Normal subjects	100	0.20	0.16–0.30
Subjects where a heart attack was confirmed using an ECG	72	15.30	9.60–22.70
Subjects with other injuries but no heart attack occurred as confirmed using an ECG	13	0.29	0.23–0.43

Table 33.1

Evaluate the evidence that the use of troponin T concentration in plasma is a useful diagnostic test to confirm a heart attack.

You should use information from **Table 33.1** to support your argument.

---

[3]

4. In addition to changes in pressure, **Fig. 37.1** also shows an ECG trace.

The part of the trace labelled T represents the repolarisation of the ventricles. Until this has happened, it is not possible for another heartbeat to occur.

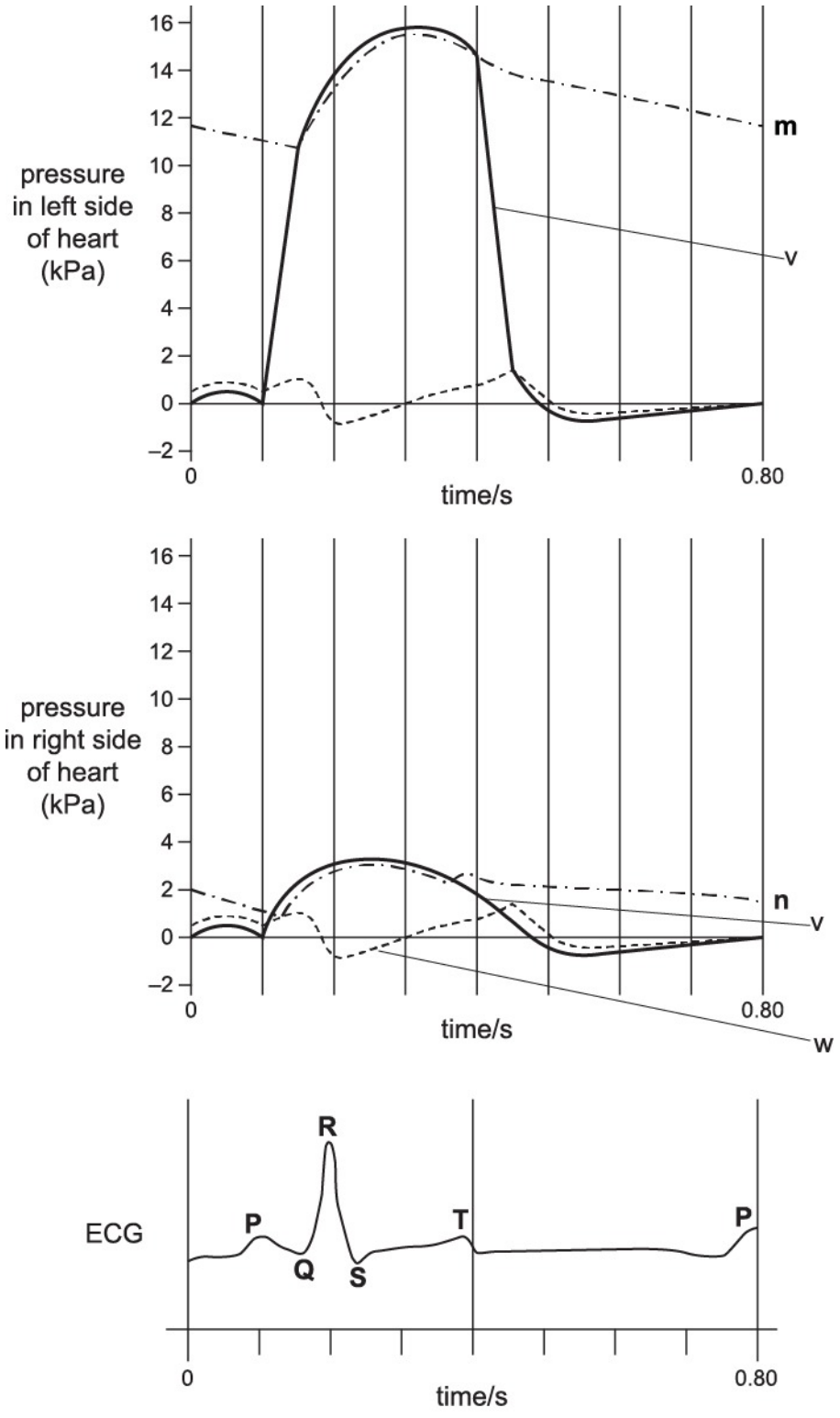


Fig. 37.1

(i) As the heart rate increases, what happens to the time between the **T** wave and the **P** wave which signals the start of the next heartbeat?

_____

_____ **[1]**

(ii) It can be dangerous in some circumstances to exercise at a level where the heart rate approaches its maximum possible.

Using the information in **Fig. 37.1**, calculate the maximum heart rate possible for the person from whom this trace was obtained.

Maximum heart rate _____ **[2]**

5(a). This question is based on the Advanced Notice article **MYOKINES**, which is an insert.

IL-6 is produced by muscle cells in response to physical exercise.

(i) Using the data in **Table 1.1**, determine the mode and mean IL-6 increase after a 1.5 hour cycle ride.

Determine the mode to **one** significant figure and the mean to **three** significant figures.

mode _____ mean _____

[3]

(ii) Based on the data in **Table 1.1**, how valid are the following conclusions?

The duration of exercise affects IL-6 concentration in blood.

Running has a greater influence than cycling on IL-6 concentrations.

---

[4]

(b).

(i) Suggest how IL-6 increases the uptake of glucose from the blood plasma to muscle cells **and** how it increases glucose production in the liver.

---

[3]

(ii) * *"IL-6 increases the risk of type 2 diabetes*."

Evaluate the evidence that supports or contradicts the above statement.

Use information from the article **MYOKINES**.

---

[6]

(c). Studies F and H in **Table 1.2** both used knockout mice.

(i) Outline **one** way in which a gene can be inactivated in the knockout procedure.

---[1]

(ii) Suggest **one** reason why mice are used as the model organism in the knockout procedure.

---[1]

(d). Cytokines produced in muscles are called myokines. IL-6 is an example of a myokine.

Cytokines can act as chemical signals between immune cells.

Describe **one** specific role of cytokines in the immune system.

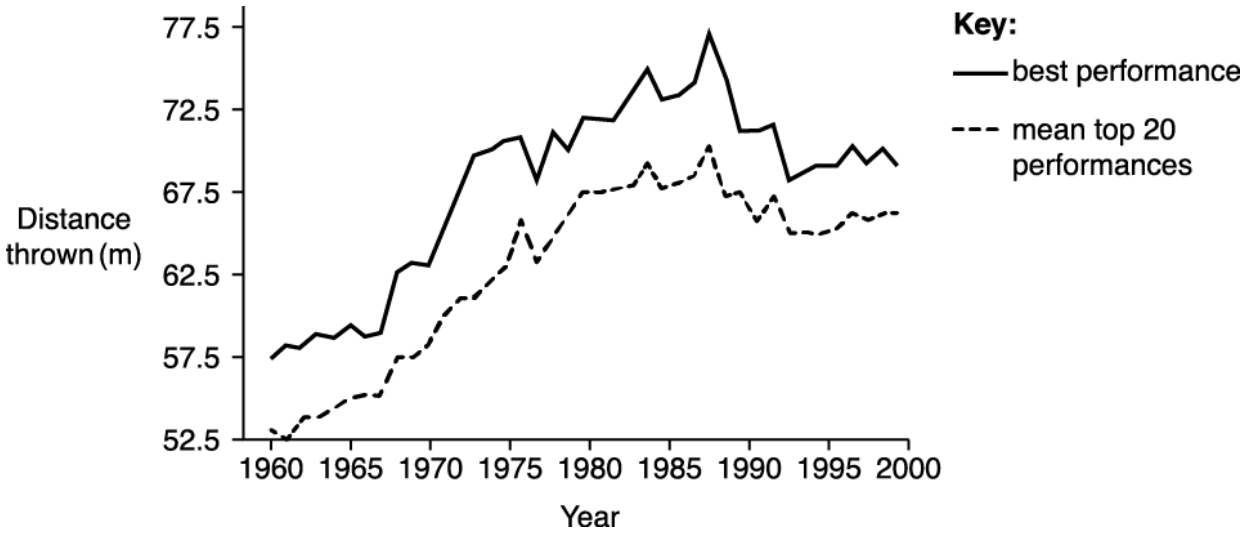
---[2]

6. Anabolic steroids, such as testosterone, are steroid hormones. Steroid hormones have a chemical structure similar to that of cholesterol.

Selected athletes are tested for drugs during sports competitions.

'Out-of-competition' drug testing, introduced in the late 1980s, is carried out randomly on all athletes. It is believed that steroid use declined at about the same time as out-of-competition drug testing was introduced.

The figure shows the changes in performance in another Olympic throwing event, the women's discus, from 1960 to 2000.



A student stated the following:

"Previous improvements in performance before the introduction of out-of-competition drug testing must have been due to the illegal use of steroids."

Evaluate whether the evidence shown in the figure supports the student's conclusion.

[2]

7(a). The contraction and relaxation of human muscles relies on interactions between different proteins within muscle cells.

In skeletal muscles, the proteins are arranged in bundles known as **myofibrils**.

Fig. 4.1 shows simplified diagrams of some of the proteins present in muscle myofibrils.

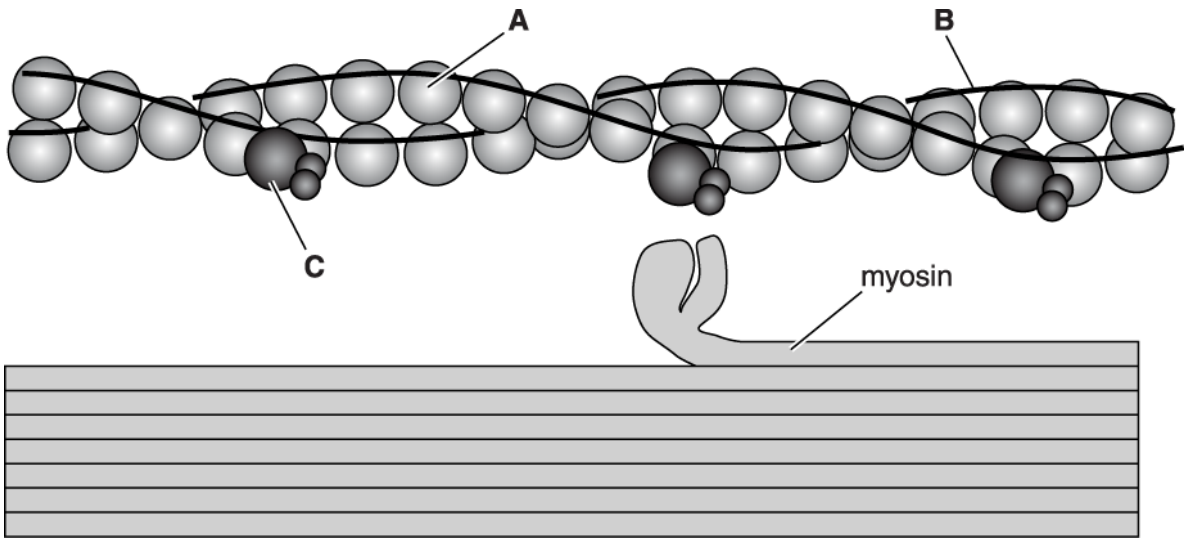


Fig. 4.1

Using the letters **A**, **B** or **C**, identify the following proteins on Fig. 4.1.

tropomyosin _____

troponin _____

[2]

(b). The proteins in skeletal muscle myofibrils are arranged in groups to form a repeating pattern. As the muscle contracts, the pattern changes.

Describe how the **pattern** within a myofibril changes when skeletal muscle contracts.

In your answer, you should use the appropriate technical terms spelled correctly.

[3]

(c). The role of dystrophin is to protect the membranes such as the sarcoplasmic reticulum from damage during muscle contraction.

The sarcoplasmic reticulum stores calcium ions in the relaxed muscle cells.

An early sign of **DMD** in muscles is a delay in muscle relaxation following a contraction.

Suggest why muscle cells fail to relax following a contraction if dystrophin is not functioning correctly or is absent.

[2]

8. Fats can only be used as a respiratory substrate if conditions within the muscles remain aerobic **and** if some carbohydrate is available.

This is often summarised by fitness trainers in the saying:

'Fats burn in a carbohydrate flame'.

(i) Suggest why fats can only be broken down in aerobic respiration.

---

[2]

(ii) Name the carbohydrate compound stored in muscle cells and briefly describe one method used by athletes to increase this store.

carbohydrate compound _____

method _____

---

[3]

9(a). After the London 2012 Olympic Games, a 'blog' on the UK's Department of Health website stated:

> 'we must deliver on our promise to create a sustainable and long term health legacy and encourage the nation to get more active, not just in the next few months but for years to come'
>
> (14th August 2012)

There are health benefits associated with taking regular exercise.

One benefit of long term exercise is a decrease in blood cholesterol level.

(i) Why does a reduction in blood cholesterol levels benefit the cardiovascular system?

____

____

____

____

____ [2]

(ii) State **one** benefit of exercise on the **skeletal** system.

____

____ [1]

(b). The ability of the body to take in, transport and use oxygen is known as the VO_2 max.

- One consequence of taking regular aerobic exercise is that the VO_2 max increases.
- Some athletes use illegal methods such as taking recombinant erythropoietin to increase their VO_2 max.

(i) State the organelle where aerobic respiration takes place **and** the stage of aerobic respiration that requires oxygen.

Organelle _____

Stage of aerobic respiration _____

_____

[2]

(ii) Explain why the use of recombinant erythropoietin increases the VO_2 max.

_____

_____

_____

_____

_____ **[2]**

10.

(i) All three types of muscle in a mammal's body contribute to the 'fight or flight' response.

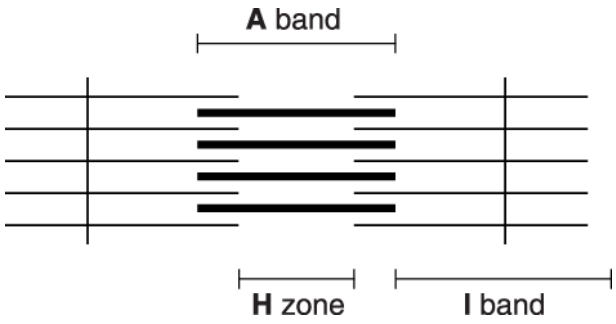
Complete the table below by filling in the blank boxes.

Organ	Type of muscle	Action of muscle in fight or flight response
heart		increases pulse rate
leg muscle		
arteriole to liver	smooth	

[3]

(ii) Muscles in a mammal's leg are made up of units.

The figure is a diagram of one unit.



The thick lines in the **A** band represent a protein.

Name this protein.

---

[1]

11(a) The recovery time of the heart is a good indicator of aerobic fitness.

.

A widely-publicised training programme claimed to improve aerobic fitness for various exercises after three months. To evaluate this claim, an investigation was conducted:

- 20 volunteers completed a series of test exercises at increasing intensities
- recovery time was recorded after each exercise
- the volunteers followed the training programme for three months
- after three months, the test exercises and measurements were repeated.

(i) State **two** factors, other than **intensity of exercise**, that must be considered before an exercise is included in a training programme.

1 ----------

2 ---------- [2]

(ii) Suggest **one** safety precaution that should have been taken before any volunteers took part in the exercises.

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

(b). The results of the investigation are shown in Fig. 36.

The columns represent the mean recovery times before and after the training. The error bars represent the standard deviation above and below the mean.

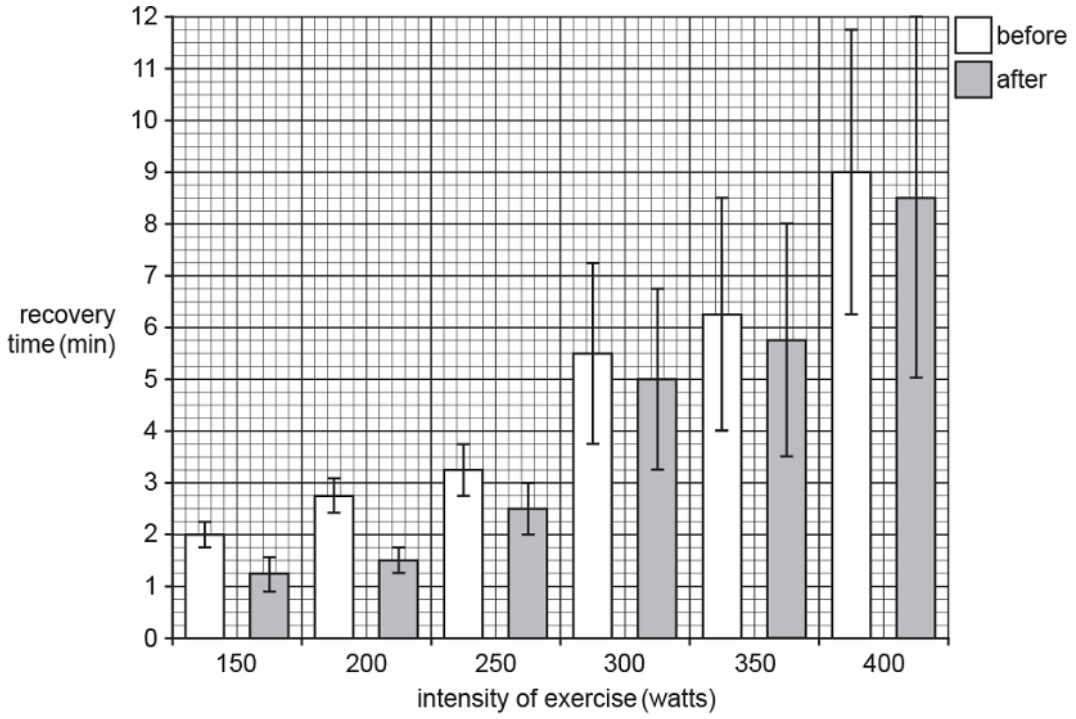


Fig. 36

(i) Name **one** statistical test that could be used to analyse the data in Fig. 36. Justify your choice.

---

[2]

(ii) Comment on how well this training programme improved fitness.

---

[2]

(iii) Promoters of the training programme claimed that it was good for training **weightlifters**. Comment on the **validity** of this statement.

---

[2]

12. Patients with chronic anaemia have reduced levels of haemoglobin in their blood. When anaemia develops over a long period of time, the concentration of the compound 2,3-bisphosphoglycerate (2,3- BPG) in the blood increases.

Fig. 6 shows the oxygen dissociation curves of haemoglobin from two individuals, one suffering from chronic anaemia and the other a normal control.

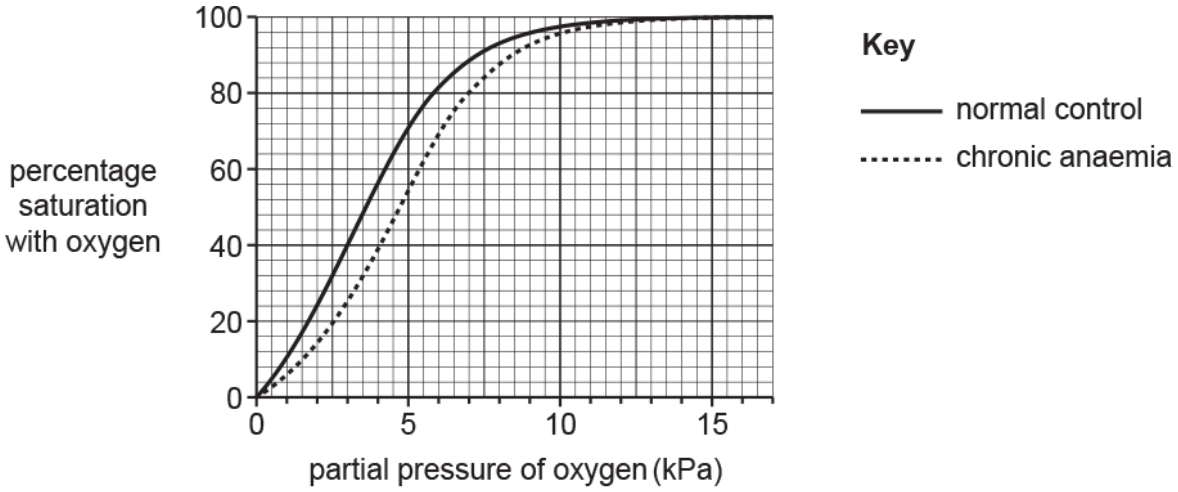


Fig. 6

(i) P_{50} is the partial pressure of oxygen at which haemoglobin is 50% saturated.

Using Fig. 6, calculate the percentage increase in P_{50} in the anaemic patient compared with the normal control.

Show your working. Give your answer to **three** significant figures.

Answer = _____ %**[2]**

(ii) Using the data in **Fig. 6**, describe the effect of 2,3-BPG on the oxygen affinity of haemoglobin.

Explain how this effect might partially compensate for the reduction in levels of haemoglobin that occur in anaemic patients.

---

[3]

13. EPO can now be produced using recombinant DNA methods. The product is called rhEPO and has been used by athletes to enhance performance. This 'blood doping' has been banned since the early 1990s and anti-doping agencies have used a combination of blood and urine tests to detect the illicit use of rhEPO.

(i) Suggest how the use of rhEPO can be detected in a blood sample.

---[2]

(ii) Suggest why it has been difficult to determine the illicit use of rhEPO in the past.

---[2]

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1		i	find named artery ; press on artery, with two fingers ; calculation of bpm ;	2 max	CREDIT radial or carotid e.g. 15 seconds and multiply by 4 Examiner's Comments Was well answered and a significant proportion of responses could have been credited for all three marking points.
		ii	*idea that* the, heart / named chamber, does not fully empty ; AVP ;	1 max	ACCEPT blood pools e.g. fibrillation damages endothelium (triggering clotting) Examiner's Comments Good responses demonstrated an understanding that atrial fibrillation would result in the ineffective pumping action of the heart and pooling of blood. Where candidates described the damage caused to the heart they were often not specific enough and gave general terms about the cardiac muscle rather than the endothelium.
			Total	3	
2		i	*respiratory arrest* person stops breathing ; *peak expiratory flow rate* maximum rate at which air can be forcibly breathed out (through mouth) ;	2	IGNORE ref to pulse and heart rate Examiner's Comments The majority of candidates were able to correctly describe what was meant by 'respiratory arrest' but fewer were able to consolidate this with the second marking point for 'peak expiratory flow rate'. Many candidates incorrectly referred to maximum volume of air leaving the lungs rather than maximum rate which suggested lack of understanding of the term.

Question			Answer/Indicative content	Marks	Guidance
		ii	forced expiratory volume per second / FEV_1 ;	1	Examiner's Comments Good responses gave both the term and the correct abbreviation. Vital capacity and tidal volume were the most common incorrect responses offered and reference to spirometer was also seen by examiners which suggested that candidates had confused the equipment being used in this instance.
		iii	expired air resuscitation ;	1	ACCEPT CPR or respired air resuscitation or rescue breathing or mouth to mouth resuscitation
		iv	do not tilt head back so far ; breathe into baby's mouth and nose / AW ; reduce, force / volume, of breaths ; increase frequency of breaths / AW ;	1 max	ACCEPT reduced depth of compressions in context of CPR
			Total	5	

Question			Answer/Indicative content	Marks	Guidance
3		i	troponin, binds to / AW, tropomyosin myosin binding site is blocked (by tropomysin) / *idea that* myosin is prevented from binding to actin	2	
		ii	comparison of median values in support of a statement / comparison of interquartile range values in support of a statement *plus any two from the following marks up to a maximum of 3* *idea that* (very) high concentrations are only seen where a heart attack is confirmed / heart attack subject have significantly higher median values than other groups *idea that* bottom of interquartile range for confirmed heart attacks is significantly higher than other groups / top of interquartile range of other groups is significantly below bottom of range for group with heart attack *idea that* unlikely to get 'false positives' or 'false negatives' *idea that* sample sizes are very different in the three groups and could affect the validity of the data	3	DO NOT ALLOW a simple description of the concentrations for each group – look for a clear statement that the high levels are specific to a heart attack or that they are significantly higher for this group.
			Total	**5**	
4		i	Time between them gets less / AW	1	
		ii	**Any 2 from:** Minimum time for 1 beat = 0.3 seconds (distance from first P to T wave) 60 ÷ 0.3 Answer = 200 bpm / beats per minute	2	
			Total	**3**	

Question			Answer/Indicative content	Marks	Guidance
5	a	i	mode = 2 mean = 3.11	3	(2 × 9) + (2 × 8) + (3 × 11) + (6 × 7) / 35 = 3.11 **Award one mark** if a candidate has clearly taken the number of participants into account but has made an error in the calculation
		ii	*General points* *Idea of* valid conclusions would require information about the intensity of exercise *Idea that* (named) statistical test would confirm conclusion *Duration (up to a maximum of 2 marks)* positive correlation (suggests the conclusion is valid) many studies / repeats / AW, improves validity *idea of* relationship / correlation, clearer for cycling (than running) *Running vs cycling (up to a maximum of 2 marks)* *idea that* (conclusion is valid because) for a given duration, IL-6 increases more with running (than cycling) the number of participants varies, which makes comparison difficult	4	**The general point marks can be scored for either section, but can only be scored once** **ALLOW** 'meta-analysis' for 'many studies' **ALLOW** calculated example
	b	i	**Any 3 from:** *Glucose uptake* (IL-6) increases / AW, insulin production (IL-6) increases / AW, insulin receptor sensitivity (on muscle cells) *Glucose production* (IL-6) increases / AW, glucagon production glycogen converted to glucose (in liver cells)	3	**ALLOW** acts like a hormone **ALLOW** glycogenolysis
		ii	*** Level 3 (5–6 marks)** Candidate's evaluation demonstrates excellent judgement of the data, providing conclusions that address all the significant issues. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.*	6	**Examples of relevant scientific points at L3 (in addition to points at L1 and L2)** *experimental & epidemiological evidence* • discussion of *in vitro* v *in vivo* experiments (e.g. the conflicting results in A and B; *in vitro* experiments might lack important factors, for example, found in *in vivo*) • discussion of the link between TNF and IL-6 (e.g. G and H. IL-6 could, for

Question			Answer/Indicative content	Marks	Guidance
			Level 2 (3–4 marks) Judgement is made on a range of aspects of the data, but conclusions are not comprehensive. *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence*. **Level 1 (1–2 marks)** Simple conclusions are made, drawing on limited aspects of the data. *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear*. **0 marks** No response or no response worthy of credit.		example, be high in certain cases because it has a defensive role against TNF) i.e. detailed links made between studies in Table 1.2 and impact on diabetes risk • in depth discussion of correlation v causation (e.g. C and D show correlation but not causation). *biological knowledge* • detailed understanding of the causes and symptoms of type 2 diabetes. **Examples of relevant scientific points at L2 (in addition to points at L1)** *experimental & epidemiological evidence* • discussion of correlation v causation • linking exercise, low baseline IL-6 and possible effects on diabetes risk • quite detailed links made, some in detail, between studies in Table 1.2 and the impact on diabetes risk. *biological knowledge* • good understanding of the causes and symptoms of type 2 diabetes. **Examples of relevant scientific points at L1** *experimental & epidemiological evidence* • basic links made between studies in Table 1.2 and the impact on diabetes risk. *biological knowledge* • some understanding of the causes and symptoms of type 2 diabetes.
	c	i	*idea that* (gene is) replaced / disrupted / AW, with, artificial / synthetic / AW, DNA	1	

Question			Answer/Indicative content	Marks	Guidance
		ii	Any 1 from: (mice have) similar, genome / DNA sequences, to humans (mice have) similar, metabolism / physiology, to humans (mice are) easy / cheap, to, house / manipulate / breed	1	
	d		chemotaxis attraction of neutrophils (to site of infection) OR cause / stimulate, B cells / T cells, to, differentiate / proliferate cause / stimulate, B cells to release antibodies OR inhibit virus replication activation / AW, of T killer cells	2	ALLOW (undergo) clonal expansion
			Total	20	

Question	Answer/Indicative content	Marks	Guidance
6	*YES* performances declined after ban; *NO* performances did not drop back to 1960s level;	Max 2	IGNORE ref. to distance figures quoted from the graph CREDIT ORA CREDIT performances declined, after testing introduced / late 1980s / 1985 onwards DO NOT CREDIT performances declined after 1980-1984 DO NOT CREDIT performance continued to improve after late 1980s IGNORE performance continued to improve after 1980 (as testing was not introduced until the late 1980s) Examiner's Comments This looked at factors that contribute to improved athletic performance based on the taking of anabolic steroids. Initially the mechanism of their entry into the nucleus was considered. The percentage increase in an athlete's performance who had taken anabolic steroids was calculated from graphical data. Two ways in which anabolic steroids could improve athletic performance were taken into account followed by an evaluation of athletic performance before and after out of competition drug testing was introduced in the late 1980s. The question tested both AO1, AO2 and AO3. Although many candidates correctly identified a decline in performance after the late 1980s when out-of-competition drug testing was introduced. Few succeeded in noting that the reduced levels of performance were still higher than those achieved in 1960 and therefore could not be due to the use of steroids. Evaluative questions require that both sides of an argument are stated. A noticeable number

Question			Answer/Indicative content	Marks	Guidance
					of candidates lost marks by incorrectly relating their answer to testing starting after 1980 and not in the late 1980s.
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
7	a		B; C;	2	**Mark the first answer on each prompt line.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = **0 marks** **Examiner's Comments** This required an understanding of the interaction between the different proteins involved in muscle contraction and how a genetic mutation can bring about changes in a protein (dystrophin). An explanation of the consequent effects of this mutation was then required. The reason for lack of detection of the condition by amniocentesis or CVS was also tested.
	b		**Z (lines)**, move closer / AW; as) **sarcomere,** shortens / AW; **I (band)** and **H (zone)**, decrease / get shorter / AW; **A (band)** stays the same, size / length; **QWC**;	2 1	 **Both** I band **and** H zone needed for the mark **Award** if any **3** of the following are used correctly with correct spelling **Z line** **sarcomere** **I band** **A band** **H zone** **Examiner's Comments** There were some very good answers but others failed to remember all the details or a detailed description of the interchanges between actin, myosin and the binding of calcium to troponin. Many candidates knew that the sarcomere shortens even if they didn't know anything else. There seemed to be a lot of confusion between lines, zones and bands, but many managed to get the QWC mark anyway.

Question			Answer/Indicative content	Marks	Guidance
	c		calcium ions / Ca^{2+} / Ca^{++}, are not reabsorbed / AW; (calcium ions / Ca^{2+} / Ca^{++},) stay bound to / not released from, troponin; (so) binding sites, on actin, (still) exposed / AW; cross bridges / AW, keep forming;	2	IGNORE reference to release of calcium ions CREDIT tropomyosin still displaced CREDIT a description 'myosin stays bound to actin, Examiner's Comments Many answers to **(i)** failed to score marking points due to a systematic lack of detail in each stage involved. Many answers 'jumped' from a gene mutation (without the detail of specific possible changes in DNA) to a change in an amino acid or change in protein shape. All the marking points appeared in various answers but few scored beyond three marking points due to missing out necessary detail. Although many candidates related the failure to relax to the continued release of calcium ions rather than their lack of reabsorption, many had a good understanding of the reason for the failure to relax in terms of myosin remaining bound to actin, and also that calcium ions remain bound to troponin.
			Total	7	

Question			Answer/Indicative content	Marks	Guidance
8		i	*idea that* fats contain, large number of, hydrogen (atoms) / carbon hydrogen bonds; hydrogen and oxygen form water (in aerobic respiration); *idea that* metabolic pathway (for fat respiration) is in mitochondria; (mitochondria) use oxygen as terminal acceptor (for hydrogen ion / electron);	2	IGNORE DO NOT CREDIT H^+
		ii	glycogen; carbo(hydrate)depletion / described (for around 10 days before event); (followed by) carbo(hydrate)loading / described (for around 3 days before event);	3	Correct spelling only CREDIT a description of diet high in protein **and** low in carbohydrate or foods which meet this description DO NOT CREDIT 'eat only protein' for 'carbodepletion' CREDIT a description referring to foods high in carbohydrate such as rice, pasta etc. Examiner's Comments Many candidates struggled and seemed to find part **(i)** hard and few seemed aware that fats contained a large number of hydrogen atoms, or the involvement of oxygen in the formation of water. Some of the more able candidates recognised the fact that oxygen was a terminal hydrogen ion acceptor even if they did not make the earlier links. Most candidates knew that glycogen was the carbohydrate storage compound in part **(ii)**, and that carbohydrate depletion should be followed by carbohydrate loading within specified time limits. Unfortunately many candidates lost a marking point, as they did not distinguish between the two stages putting the whole procedure under the description of carbohydrate loading.
			Total	5	

Question			Answer/Indicative content	Marks	Guidance
9	a	i		2	*The question refers to the effect of blood cholesterol not exercise on the cardiovascular system.*
			idea that reduces, (risk /cases / AW, of) atherosclerosis / atheroma (s);		ACCEPT a description e.g. less plaque, or less fatty deposit **in** artery walls DO NOT CREDIT 'less ON artery wall or IN artery' DO NOT CREDIT idea that atherosclerosis causes high blood pressure
			idea that reduces, (risk / cases, of,) coronary heart disease / heart attacks;		ACCEPT a description e.g. prevents CHD / MI / Angina IGNORE heart disease unqualified, IGNORE ref to strokes as the question is about benefits to the cardiovascular system Examiner's Comments This question asked about the benefits of exercise in terms of the beneficial effects of lowering blood cholesterol, the effects of exercise on the skeletal system and the practical aspects of investigating aerobic fitness including data analysis. The question tested AO1, AO2 and AO3. In part (i) many candidates were well aware of the reduced risk of atherosclerosis and named heart problems. A number of candidates who made references to strokes had not read the question properly missing the fact that it was about benefits to the cardiovascular system. There was some confusion in answers where candidates were clearly answering in terms of the effects of exercise on the cardiovascular system and not the effects of a reduction in blood cholesterol. Hence many answers

Question			Answer/Indicative content	Marks	Guidance
					incorrectly included references to changes in blood pressure. There were still a lot of references to fats blocking, or clogging, arteries, only the higher scoring candidates using the correct terminology to describe atherosclerosis.
		ii	stronger bones / increased bone density / maintains bone density; thicker joint cartilage;	Max 1	**Mark the first answer**. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = **0 marks** **CREDIT** reduction in risk of osteoporosis **IGNORE** ref to muscles / tendon / ligament **Examiner's Comments** ☐Stronger bones or a reduction in the risk of osteoporosis was the main answer given in (ii). Errors made were largely associated with references to increased muscle mass.

Question			Answer/Indicative content	Marks	Guidance
	b	i	*organelle* mitochondrion; *stage in aerobic respiration* oxidative phosphorylation;	2	**Mark the first answer**. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = **0 marks** **ACCEPT** mitochondria **IGNORE** ref to matrix or cristae **IGNORE** electron transport chain / chemiosmosis **Examiner's Comments** Most candidates seem to know that aerobic respiration takes place in the mitochondrion and that oxidative phosphorylation was the stage requiring oxygen instage requiring oxygen in (i). The most common error was referring to the electron transport chain. In part (ii) most candidates knew that RhEPO increases erythrocyte production enabling increased oxygen transport.
		ii	*idea that* RhEPO increases production of, erythrocytes / red blood cells / more haemoglobin; Increased oxygen, transport / carrying capacity / AW;	2	
			Total	**7**	

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>10</td><td></td><td>i</td><td>
<table>
<tr><th>Organ</th><th>Type of muscle</th><th>Action of <u>muscle</u> in fight or flight response</th></tr>
<tr><td>Heart</td><td><u>cardiac</u></td><td>increase pulse rate</td></tr>
<tr><td>Leg muscle</td><td>voluntary / skeletal/striated</td><td>contract</td></tr>
<tr><td>Arteriole to liver</td><td>smooth</td><td>contract / relax</td></tr>
</table>
;
;
;
</td><td>3</td><td>Mark the first answer in each box. If that answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks.

IGNORE relax for second box

ACCEPT (vaso)constrict / (vaso)dilate for third box (as in context of effect of muscle on arteriole)
IGNORE increases/decreases, blood flow
IGNORE increases/decreases, diameter

Examiner's Comments

The mark most often scored in (c)(i) was for naming cardiac muscle as being present in the heart. Striated muscle for contraction often scored a second mark but candidates were prone to contradict themselves in the third line of the table, saying the effects of arteriole smooth muscle contraction caused dilation or increased blood flow to liver rather than constriction (and reduced blood flow).</td></tr>
<tr><td></td><td></td><td>ii</td><td>myosin;</td><td>1</td><td>IGNORE thick filament.
DO NOT CREDIT myelin
Mark the first answer. If that answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks.

Examiner's Comments

Most candidates correctly identified the thick filaments in the A band as myosin. A few wrote actin instead, and very occasionally tropomyosin was given as the answer.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>4</td><td></td></tr>
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Question			Answer/Indicative content	Marks	Guidance
11	a	i	frequency of exercise ✓ time / duration, of exercise ✓ type of exercise ✓	max 2	Examiner's Comments Both **(a)(i)** and **(ii)** were answered well. Candidates are advised to be specific when referring to safety precautions and avoid generalisations such as 'health checks'.
		ii	(check for) asthma / heart condition / pregnancy / high blood pressure ✓ equipment training ✓	1	Examiner's Comments Both **(a)(i)** and **(ii)** were answered well. Candidates are advised to be specific when referring to safety precautions and avoid generalisations such as 'health checks'.
	b	i	(Student's) t-test ✓ paired / measurements from same people (before and after) ✓	2	Examiner's Comments It was encouraging to see that over 60% of candidates were awarded at least one mark when asked about the type of statistical test that could be used to analyse the data in **(b)(i).** A significant number of candidates justified their choice, clearly explaining how measurements were taken from the same people before and after exercise.
		ii	improvement in recovery time (at all intensities / wattages of exercise) ✓ improvement falls as intensity / wattage rises ✓ uncertainty in making conclusion because standard deviations / error bars (for before-and-after) overlap ✓	2	ORA Examiner's Comments **(b)(ii)** was another example where candidates showed that they could describe data clearly. They were also able to identify that large error bars illustrated the data was variable but often failed to develop the idea of lack of significance when error bars overlapped.
		iii	higher intensity / wattage exercises such as weightlifting show less improvement in recovery time ✓ weightlifting is not an aerobic exercise ✓ weightlifting occurs over a short duration / in short bursts ✓	2	ORA ALLOW if not awarded in (b)(ii) uncertainty in making conclusion (about weightlifting) because standard deviations / error bars (for before-and-after) overlap Examiner's Comments **(b)(iii)** required candidates to understand that weightlifting is not an aerobic exercise and occurs in short bursts so this training programme, which candidates were told focused on aerobic fitness, would not be appropriate.

Question			Answer/Indicative content	Marks	Guidance
			Total	9	
12		i	(correct determination of P_{50} for **both** curves) normal = 3.5 and anaemia = 4.5 ✓ (calculation of % increase to 3 sig. figs) 28.6 ✓	2	**ALLOW** +/– 0.2 for each P50 value **ALLOW ECF** from incorrect P_{50} values **Examiner's Comments** The calculation in **(a)(i)** was correctly worked out by the majority of candidates. Marks were lost for quite high P_{50} values, particularly for the anaemia curve.
		ii	Hb / its, affinity (for O_2) would decrease / reduce ✓ oxyhaemoglobin, dissociates at <u>higher</u> pO_2 / has lower (%) saturation (than normal control) at same pO_2 ✓ (limited) haemoglobin releases oxygen more, easily / readily ✓ so <u>more</u> oxygen to (respiring) tissues ✓	3	**Examiner's Comments** There appeared to be 2 interpretations for **(a)(ii)**. Those candidates that felt BPG increased Hb oxygen affinity described the relevance of this to a drop in haemoglobin levels in anaemic patients with a sensible, logical pattern. However they had not related the shift in the curve to the Bohr shift and thus a decrease in affinity. Candidates should be reminded that the affinity of haemoglobin for oxygen is relevant when oxygen needs to be released as well as needing to pick up oxygen. Candidates that understood the decrease in affinity then followed through with clear, logical answers.
			Total	5	

Question			Answer/Indicative content	Marks	Guidance
13		i	measure number of, red blood cells / RBCs /erythrocytes ✓ high number of RBCs indicates use of rhEPO✓ use of (fluorescent) antibodies to detect rhEPO ✓	2 max	ALLOW use flow cytometry ALLOW use of ELISA / immunoassay, to detect rhEPO <u>Examiner's Comments</u> This was well answered with many candidates stating the use of haemocytometers for counting red blood cells. A number of candidates thought that the presence of rhEPO could be detected by the presence in the blood of recombinant DNA coding for rhEPO, or even recombinant plasmids. A few candidates suggested using a Biuret test, so although they appreciated EPO was a protein, they did realise this would detect all blood proteins.
		ii	rhEPO is identical to the normal EPO ✓ normal EPO concentrations vary (so difficult to know when rhEPO is added)✓	2	ALLOW cannot tell difference between types of EPO ALLOW difficult to establish normal EPO concentration <u>Examiner's Comments</u> The majority of candidates did not appreciate the presence of normal EPO as well as rhEPO and thus could not compare the structures of the two. Most answers discussed the limitations in methods available in the past.
			Total	4	