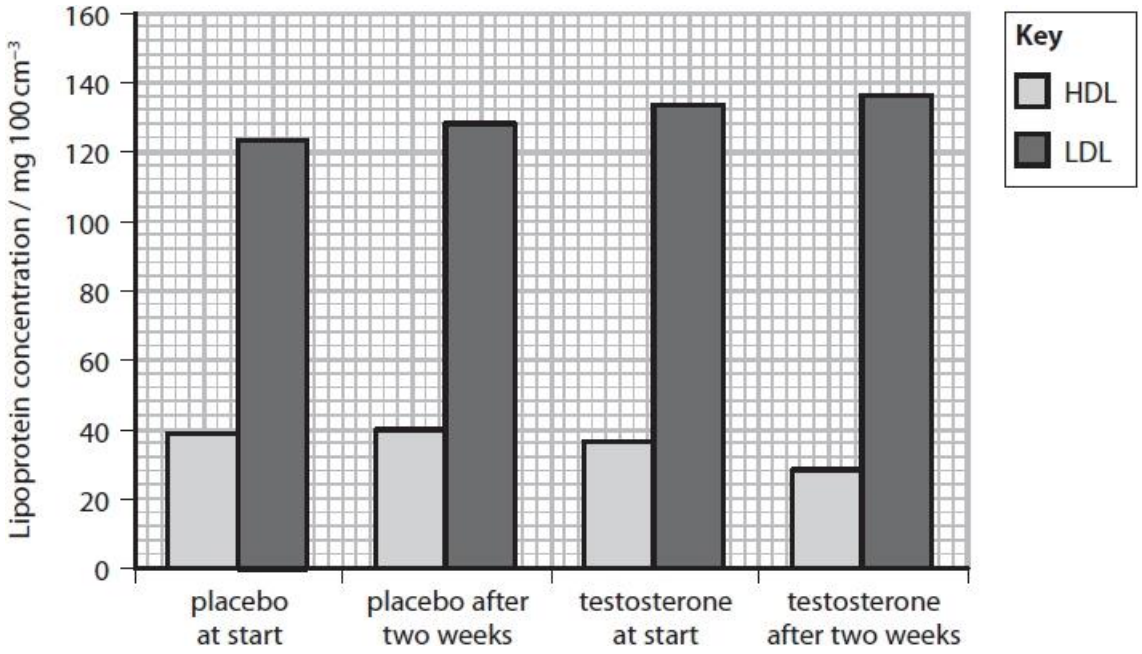
## Questions

**Q1.**

Anabolic steroids and testosterone have been used as performance-enhancing drugs by some athletes. These drugs can increase muscle mass and strength.

In another investigation, groups of men were given either a placebo or 300 mg of testosterone per week for two weeks. The concentrations of different lipoproteins (HDL and LDL) in the blood were measured at the start of the investigation and after two weeks.

The results of the investigation are shown in the graph.




(i) The ratio of total cholesterol to HDL is used as an indicator of the risk of cardiovascular disease. The higher the ratio of total cholesterol to HDL, the greater the risk.

In this investigation, the men given the placebo had a total cholesterol to HDL ratio of 4.2:1 after two weeks.
Calculate the ratio of total cholesterol to HDL for those taking testosterone after two weeks.

**(2)**

Ratio of total cholesterol to HDL .....

*(ii) Doses of testosterone are used to enhance performance in sports by increasing muscle mass and therefore strength.

- Testosterone increases the activity of an enzyme in the liver that breaks down HDL.
- The production of cholesterol is catalysed by the enzyme HMG CoA reductase (HMGCR).
- Testosterone increases levels of mRNA for HMGCR.

Explain why using testosterone as a performance-enhancing drug is unacceptable in terms of risks to health.

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**(Total for question = 8 marks)**

**Q2.**

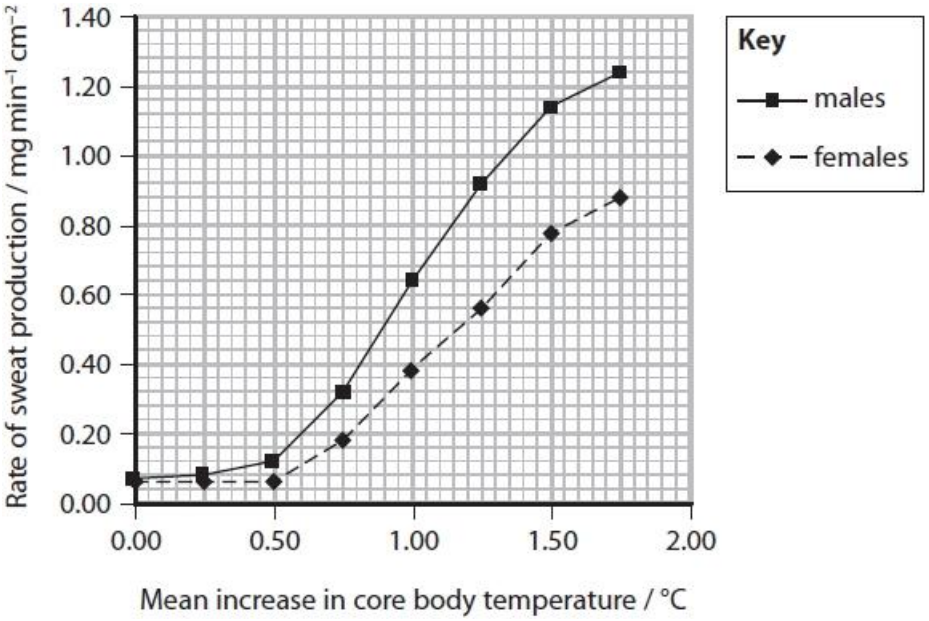
Athletic competitions often take place during the summer months when ambient temperatures are high.

High ambient temperatures affect marathon runners.

Heat stress occurs when the core body temperature rises above 40 °C.

Physical and physiological differences between males and females affect thermoregulation.

The graph shows the effect of a mean increase in body temperature on the rate of sweat production by males and females.




Female marathon runners have smaller bodies, with a larger ratio of skin surface to body mass than males.

Male marathon runners have less body fat than females: 5–11% compared with 10–15%.

Comment on how gender could affect thermoregulation in marathon runners.

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**(Total for question = 4 marks)**

**Q3.**

Anabolic steroids and testosterone have been used as performance-enhancing drugs by some athletes. These drugs can increase muscle mass and strength.

An investigation was carried out to assess the effect of doses of testosterone on muscle size.

A group of men was randomised into four groups: A, B, C and D. Groups A and B were given a placebo. Groups C and D were both given doses of testosterone. Groups A and C had no exercise training. Groups B and D were given exercise training.

The cross-sectional area of the triceps muscle of each individual was measured at the start of the investigation and after 10 weeks.

The results are shown in the table.

| Muscle | Mean cross-sectional area of muscle / $mm^2$ ± SD | | | |
|---|---|---|---|---|
| | Group A Placebo without exercise | Group B Placebo with exercise | Group C Testosterone without exercise | Group D Testosterone with exercise |
| Triceps – at the start | 3621 ± 213 | 4052 ± 262 | 3579 ± 260 | 3483 ± 217 |
| Triceps after 10 weeks | 3539 ± 226 | 4109 ± 230 | 4003 ± 229 | 3984 ± 239 |

(i) Deduce the effect of testosterone on the size of the triceps muscle.

**(2)**

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(ii) The purpose of the placebo is to

**(1)**

☒ **A** increase the accuracy of the measurements

☒ **B** increase the reproducibility of the data

☒ **C** show that exercise has an effect

☒ **D** show that testosterone has an effect

**(Total for question = 3 marks)**

**Q4.**

Athletic competitions often take place during the summer months when ambient temperatures are high.

High ambient temperatures affect marathon runners.

Heat stress occurs when the core body temperature rises above 40 °C.

Describe how thermoregulatory mechanisms are controlled to help marathon runners avoid heat stress.

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**(Total for question = 4 marks)**

**Q5.**

A moderate amount of exercise is considered good for the human body.

A student carried out 20 minutes of physical exercise. During this time, her heart rate and level of sweating increased.

Shortly after completing the exercise, the student noted that her heart rate and level of sweating decreased.

(i) Explain the role of the brain in reducing the student's heart rate after the exercise.

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(ii) Describe how the brain reduces the activity of the sweat glands after the exercise.

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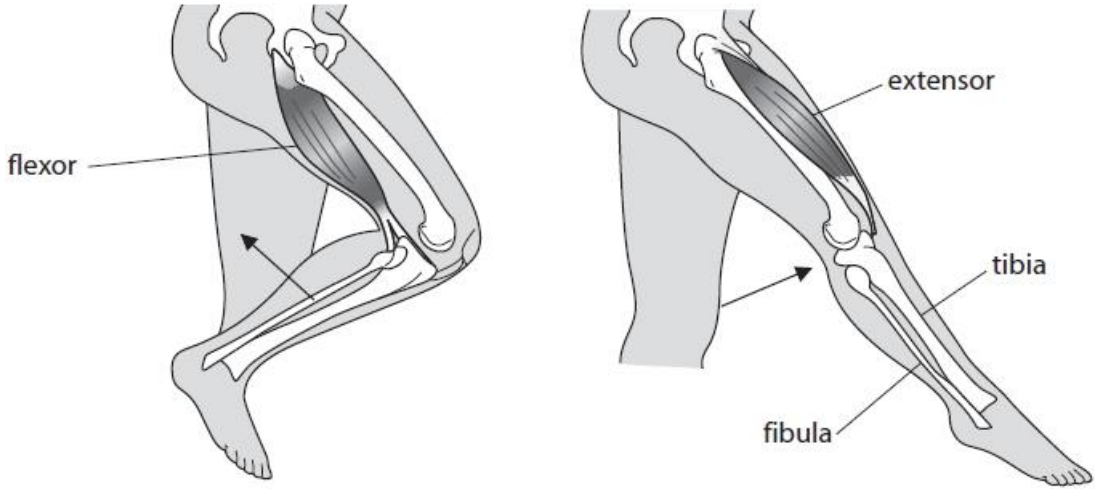
**(Total for question = 4 marks)**

**Q6.**

Sepsis is a bacterial infection in the bloodstream. Sepsis can cause tissue death in limbs. This may require parts of a limb to be removed (amputation).

Extensor and flexor muscles are involved in the movement of the lower leg as shown in the diagrams.




(i) Explain how the extensor and flexor muscles bring about movement of the lower leg.

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(ii) Individuals who have had limbs amputated can use prostheses to compete in athletic events.

A transtibial amputation involves the removal of part of the lower leg below the knee. Extensor and flexor muscles are still attached to the parts of the lower leg bones (the tibia and fibula) that remain.
The photograph shows Paralympic athletes competing in the 100m final in London 2012. The three athletes shown have all had transtibial amputations.


www.sciencephoto.com

Deduce how athletes with transtibial amputations are able to move their prosthetic limbs during a race.

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**(Total for question = 3 marks)**

**Q7.**

Explain why too much exercise could be harmful to the human body.

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**(Total for question = 3 marks)**

**Q8.**

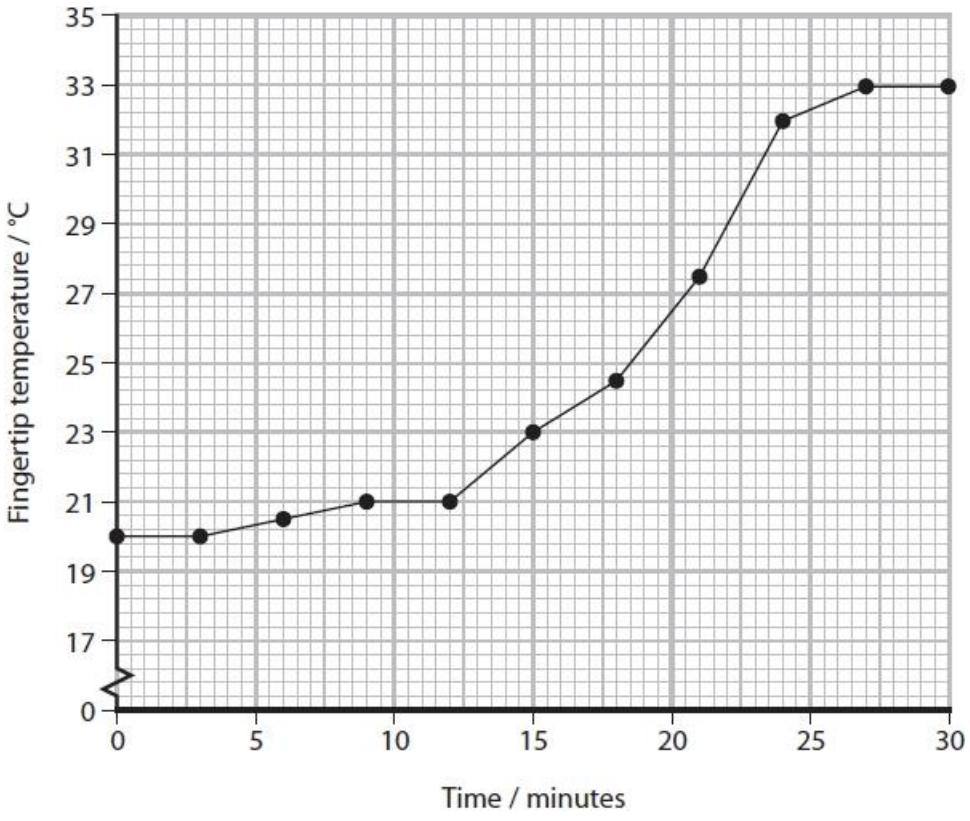
When scientists visit Antarctica, they need appropriate clothing to help with thermoregulation.

www.aa.com

An investigation was carried out to study thermoregulation in humans.

A woman was wrapped in blankets and her feet were put in hot water for 30 minutes.
During this time, the temperature of the skin at the end of one of her fingertips was recorded.

The graph shows the results of this investigation.



(i) Explain why there was no change in fingertip temperature between 0 and 3 minutes.

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(ii) Calculate the greatest rate of increase in fingertip temperature.

**(2)**

Answer .....

(iii) Explain the role of the nervous system in bringing about the increase in temperature of the fingertip as shown in this investigation.

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**(Total for question = 9 marks)**

## Mark Scheme

Q1.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **(i)** | • correct figures from graph used to calculate total cholesterol<br>• value for ratio correctly calculated | <u>Example of calculation</u><br>28 + 136 = 164<br>5.9:1 / 5.86:1<br>One mark for 164:28 | **(2)** |

| Question Number | Indicative content | |
|---|---|---|
| * **(ii)** | Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.<br><br>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.<br><br>Basic information<br>• testosterone increases production of { LDL / cholesterol }<br>• testosterone {increases breakdown of / reduces } HDL<br>• { high cholesterol / LDL } associated with increased risk of {CVD / atherosclerosis}<br><br>Evidence for linkages<br>• role of HDL in transporting cholesterol from the bloodstream to the liver<br>• role of LDL in accumulation of cholesterol and development of atherosclerosis<br><br>Evidence for sustained scientific reasoning<br>• testosterone associated with increased synthesis of the enzyme HMGCR which is involved in cholesterol production<br>• { performance enhancing drugs / testosterone } can harm the health of an athlete by increasing risk of CVD | |

| Level | Mark | Descriptor | |
|---|---|---|---|
| **Level 0** | Marks | No awardable content | |
| **Level 1** | 1-2 | An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one piece of scientific information.<br><br>The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context. | Increase in CVD due to increase in cholesterol/LDL<br><br>due to increase in production/ rate of breakdown |
| **Level 2** | 3-4 | An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information.<br><br>The explanation shows some linkages and lines of scientific reasoning with some structure. | Explanation of the role of LDL<br><br>Development of atherosclerosis |
| **Level 3** | 5-6 | An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information.<br><br>The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured. | Links made between all data. Explanation of the role of HMGCR<br><br>Detailed description of the effect on atherosclerosis |

**Q2.**

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| | An answer that makes reference to the following:<br><br>• (an increase in body temperature causes) a greater increase in rate of sweating in males than in females<br><br>• males lose heat faster because they produce sweat at a faster rate<br><br>• females have larger SA to body mass ratio that allows for { faster / more effective } heat loss<br><br>• males have less { body fat / insulation } which may allow { faster / more effective } heat loss | ALLOW converse for any marking point<br><br>ALLOW 'males sweat more'<br><br>ALLOW SA:volume | **(4)** |

**Q3.**

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **(i)** | An answer that makes reference to two of the following:<br>• increase in cross sectional area with testosterone (and not with placebo)<br>• greatest increase with testosterone and exercise<br>• significant difference for { testosterone plus exercise / group D } as the SDs (for start and after 10 weeks) do not overlap | ALLOW increase in size (of triceps muscle) | **(2)** |

| Question Number | Answer | Mark |
|---|---|---|
| **(ii)** | **D** - show that testosterone has an effect<br>*The only correct answer is **D***<br>***A** is incorrect because a placebo does not make measurements more accurate*<br>***B** is incorrect because placebos do not make data more reproducible*<br>***C** is incorrect because the placebo does not show that exercise has an effect* | **(1)** |

**Q4.**

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| | A description that makes reference to four of the following:<br>• thermoreceptors (in hypothalamus or skin) detect increase in temperature<br>• { heat loss / thermoregulatory } centre in hypothalamus stimulated<br>• (hypothalamus) sends impulses to sweat glands (1)<br>• increased blood flow to surface of skin by {vasodilation / constriction of shunt vessels}<br>• decreased metabolic rate | ALLOW impulses sent to thermoregulatory centre in hypothalamus<br>ALLOW action potential<br>IGNORE dilation of capillaries | (4) |

**Q5.**

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (i) | An explanation that makes reference to two of the following:<br>• chemoreceptors detect a change in { carbon dioxide / pH } (1)<br>• the cardiovascular control centre { receives impulses from chemoreceptors / sends impulses to the heart } (1)<br>• (therefore impulses are transmitted) along the parasympathetic { nerve / nervous system / nerve pathway } to the SAN (reducing heart rate) (1) | ALLOW cardiac control centre<br>ALLOW cardiovascular control centre sends impulses to the SAN<br>ALLOW vagus nerve | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (ii) | A description that makes reference to the following:<br>• thermoreceptors detect a decrease in temperature (1)<br>• { hypothalamus / thermoregulatory centre } sends fewer impulses to sweat glands (1) | | (2) |

**Q6.**

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (i) | An explanation that makes reference to two of the following:<br>• tendons attach muscles to bones<br>• (flexor and extensor) muscles act as an antagonistic pair<br>• when the {extensor muscle contracts, it pulls on the tibia to extend the leg / flexor muscle contracts, it pulls on the fibula flexing the leg} | ALLOW marks for correctly annotated diagram<br>ALLOW reference to a tendon attaching a named muscle to a named bone<br>ALLOW quadriceps for extensor and hamstring for flexor | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (ii) | • the muscles are still attached to (bones in) the lower leg and the prosthetic limb is attached to the lower leg (allowing movement) | ALLOW reference to tibia and/or fibula instead of lower leg.<br>No marks if reference made to muscle attachment to prosthetic limb. | (1) |

# Edexcel Biology A-level - Homeostasis and Exercise

## Q7.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| | An explanation that makes reference to three of the following:<br><br>• (increased exercise results in) wear (and tear) of { joints / cartilage / tendons / ligaments } (1)<br><br>• (therefore leading to) joint damage (1)<br><br>• suppression of immune system (1)<br><br>• (therefore leading to) increased risk of infection (1) | e.g. arthritis or a named injury<br><br>e.g. reduced { T cell numbers / antibody production }<br><br>e.g. appropriate infection such as upper respiratory tract infections, cold, influenza | (3) |

## Q8.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (i) | An explanation that makes reference to two of the following:<br><br>• time is required for heat to warm the blood (1)<br><br>• because of the layer of insulation in the skin (1)<br><br>• because it takes time for the warm blood to circulate (1) | ALLOW it takes time for warm blood to reach the fingertip | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (ii) | • maximum difference in temperature divided by time (1)<br><br>• correct answer with units (1) | Example of calculation<br><br>(32.0 - 27.5) ÷ 3<br><br>1.5 °C $min^{-1}$ OR 1.5 °C per minute OR 1.5 °C / minute<br><br>ALLOW 32.0 – 27.4 to give 1.53 for 2 marks<br><br>Correct answer no working with units gains full marks | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (iii) | An explanation that makes reference to five of the following:<br>• thermoreceptors detect increase in temperature (1)<br>• description of role of hypothalamus in heat loss mechanism (1)<br>• (therefore more) impulses are sent along the sympathetic { nerves / nervous system } (1)<br>• which leads to constriction of shunt vessels (1)<br>• therefore causing vasodilation (of arterioles) (1)<br>• so more warm blood flows near the skin surface (1) | e.g. thermoreceptors in the hypothalamus detect temperature increase OR reference to role of heat loss centre / thermoregulatory centre in co-ordinating mechanisms of heat loss<br>ALLOW so more warm blood in capillaries<br>ALLOW radiation of heat energy from the skin | **(5)** |