Homeostasis 2

Name: _____

Class: _____

Date: _____

Time: **87 minutes**

Marks: **80 marks**

Comments:

1. Rat populations can increase rapidly.

When rat populations are large there is competition between rats.

(a) When rats compete, the basal metabolic rate of the rats increases.

Basal metabolic rate is controlled in the same way in humans and in rats.

Describe how basal metabolic rate is increased.

_____

_____

_____

_____

(2)

(b) The size of a rat population can increase quickly.

One female rat and one male rat can produce 20 offspring every 2 months.

Warfarin is a poison that has been used to control rat populations.

Rat populations can become resistant to warfarin by the process of evolution.

A population of rats was given warfarin for 4 months.

The table below shows information about resistance to warfarin in the rat population for a year after warfarin was first given.

Number of months since warfarin was first given	**Was warfarin being given?**	**Percentage (%) of rat population resistant to warfarin**
0	Yes	1
2	Yes	24
4	Yes	81
6	No	99
8	No	92
10	No	85
12	No	70

Rats with resistance to warfarin have a smaller mean mass than rats that are **not** resistant to warfarin.

Smaller rats are often at a disadvantage when competing against larger rats.

Explain the trends in the data when warfarin was being given and when warfarin was no longer given.

Use the table above.

(6)

(Total 8 marks)

2. A student investigated the effect of either **seeing** a stimulus or **hearing** a stimulus on reaction time.

First, the student measured their reaction time to **seeing** a colour change.

This is the method used.

1. Sit in front of a computer with a reaction timer program open.
2. Press a key on the keyboard as quickly as possible when the computer screen changes colour.
3. Record the reaction time.
4. Repeat steps 1 to 3 four more times and calculate the mean reaction time.

Next, the student measured their reaction time to **hearing** a sound.

This is the method used.

5. Sit in front of a computer with a reaction timer program open.
6. Press a key on the keyboard as quickly as possible when the computer produces a sound.
7. Record the reaction time.
8. Repeat steps 5 to 7 four more times and calculate the mean reaction time.

(a) **Table 1** shows some variables in this investigation.

Table 1

Variable	**Independent variable**	**Dependent variable**	**Control variable**
Distractions from background sounds			
Reaction time			
Type of stimulus			

Identify each variable as an independent variable, a dependent variable or a control variable.

Tick (✓) **one** box in each row on **Table 1**.

(3)

(b) How could the method be improved?

Tick (✓) **one** box.

Measure the reaction time with a stopwatch. ☐

Only test reaction time to seeing a colour change. ☐

Repeat both methods 10 times. ☐

(1)

(c) A shorter reaction time means the student reacted faster.

The student reacted faster as each test was repeated.

Suggest **one** reason why the student's reactions got faster.

_____

_____

(1)

Table 2 shows the results.

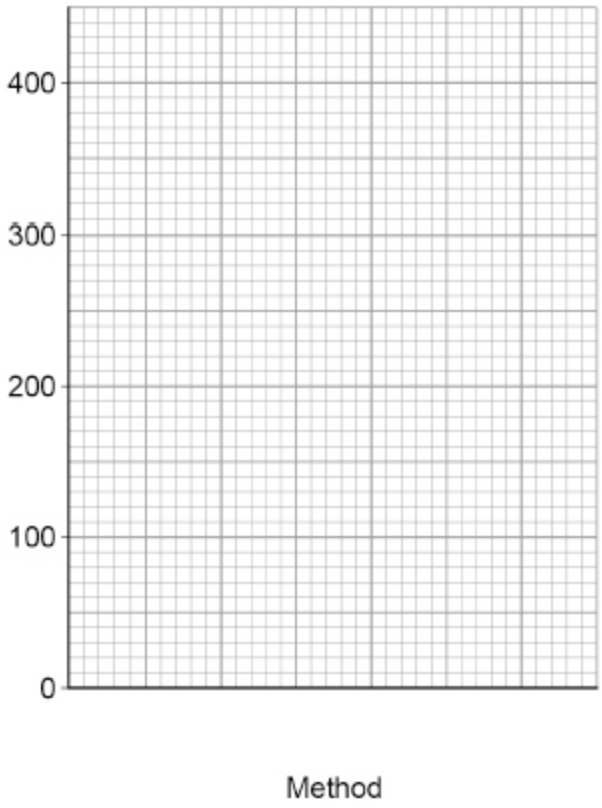
Table 2

Method	**Mean reaction time in milliseconds**
Seeing the stimulus	350
Hearing the stimulus	220

(d) Complete the figure below.

You should:

- plot the data from **Table 2** as a bar chart
- label each bar
- label the y-axis.



(2)

(e) Compare the reaction time when seeing the stimulus with the reaction time when hearing the stimulus.

_____

_____

_____

(1)

(Total 8 marks)

3. The control of body temperature is an example of homeostasis.

(a) Give **one** other internal condition controlled by homeostasis.

Do **not** refer to temperature in your answer.

_____

(1)

(b) Explain why the control of body temperature is important.

_____

_____

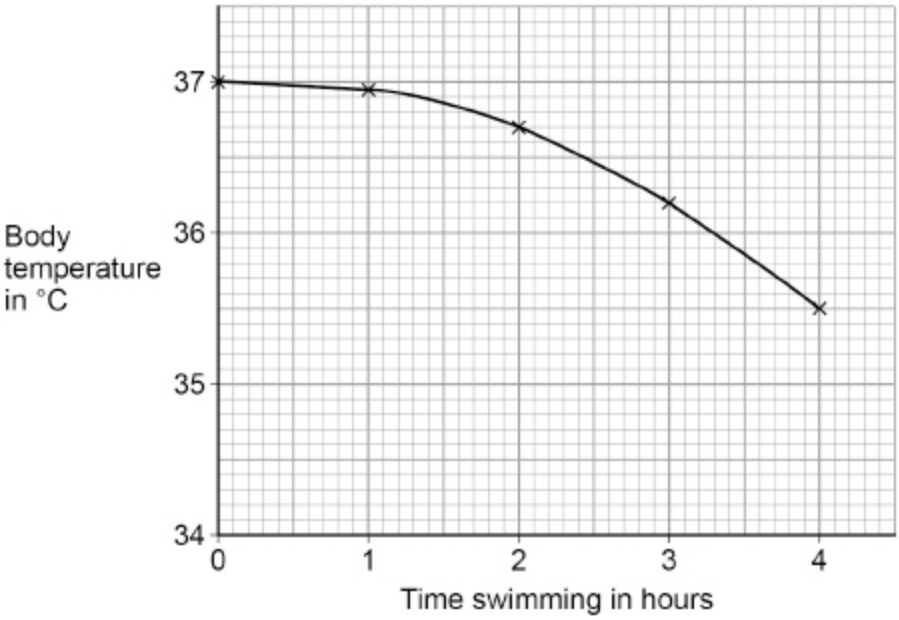
_____

_____

(2)

The body temperature of long-distance swimmers can change as the length of time swimming in cold water increases.

The figure below shows how the body temperature of one swimmer changed in the first 4 hours of a long-distance swim.



(c) Calculate the mean rate of body temperature decrease per hour in the first 4 hours of the swim.

_____

_____

_____

_____

Rate = _____ °C per hour

(2)

(d) Hypothermia is a dangerously low body temperature.

For this swimmer, a 5.5% decrease in body temperature from the start of the swim will cause hypothermia.

Determine the body temperature at which this swimmer will start to have hypothermia.

Give your answer to 2 significant figures.

Body temperature (2 significant figures) = _____ °C

(4)

A decrease in body temperature causes the adrenal glands and the thyroid gland to be stimulated.

(e) Which gland secretes hormones to stimulate the adrenal glands?

_____

(1)

(f) Explain the role of the adrenal glands in responding to a decrease in body temperature.

(5)

(g) Explain how the thyroid gland controls the response to a decrease in body temperature by negative feedback.

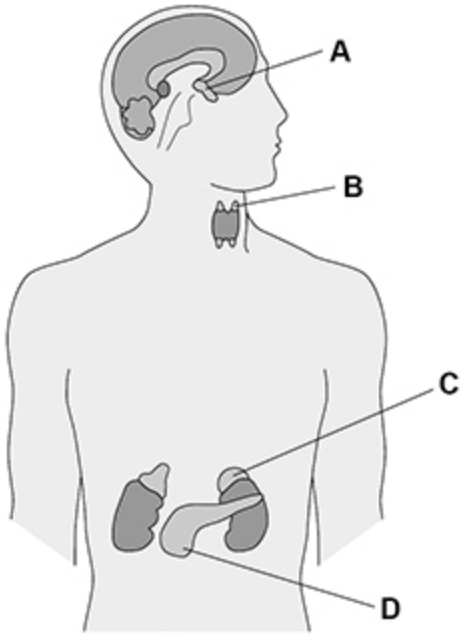
(3)

(Total 18 marks)

4. The endocrine system is made up of glands which secrete hormones.

Figure 1 shows the position of endocrine glands in the human body.

Figure 1



(a) Which letter shows the pancreas?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(b) Which letter shows the thyroid gland?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(c) Hormones travel from the gland where they are made to the target organ where they have an effect.

How do hormones travel from the gland to the target organ?

_____

_____

(1)

When blood glucose concentration becomes too high, hormone **X** from the pancreas causes a decrease in the glucose concentration.

(d) Name hormone **X**.

_____

(1)

(e) In what **two** ways does hormone **X** cause a decrease in blood glucose concentration?

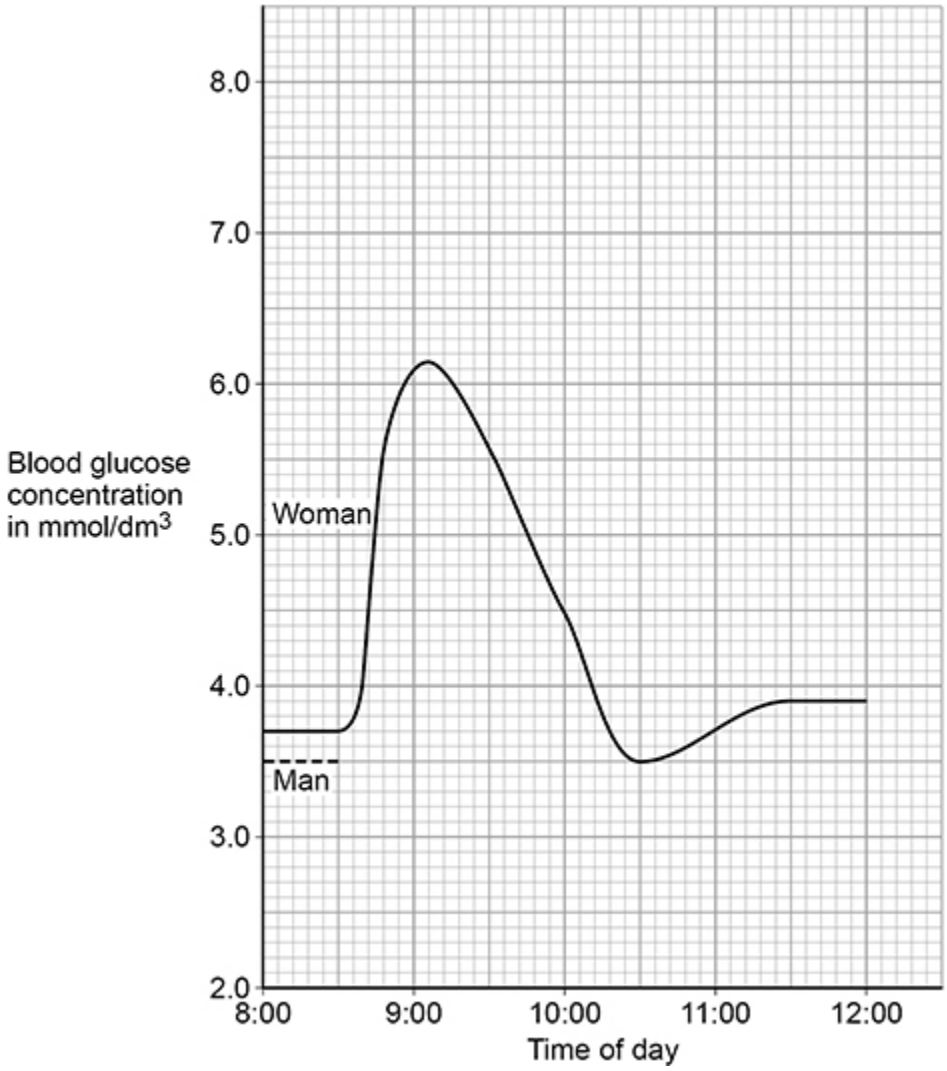
Tick (✓) **two** boxes.

Glucose is broken down.	☐
Glucose is converted to glycogen.	☐
Glucose is excreted by the kidneys.	☐
Glucose moves from the blood into the cells.	☐
Glucose moves into the small intestine.	☐

(2)

Figure 2 shows the blood glucose concentration in a woman.

Figure 2



(f) Suggest what time of day the woman ate her breakfast of sugar-coated cereal.

Time of day = _____

(1)

The man in **Figure 2** has Type 2 diabetes but he has **not** been treated.

(g) The man ate:

- the same type and amount of breakfast cereal as the woman
- at the same time as the woman.

Suggest what his blood glucose concentration would be at 9:00

Blood glucose concentration = _____ mmol/dm^3

(1)

(h) The man:

- is an obese office worker
- does not exercise
- eats sugary snacks at his desk.

Give **two** lifestyle changes a doctor might recommend to the man to help him control his diabetes.

1 _____

_____

2 _____

_____

(2)

(i) Describe how a **low** blood glucose concentration would lead to a person feeling weak.

_____

_____

_____

_____

(2)

(Total 12 marks)

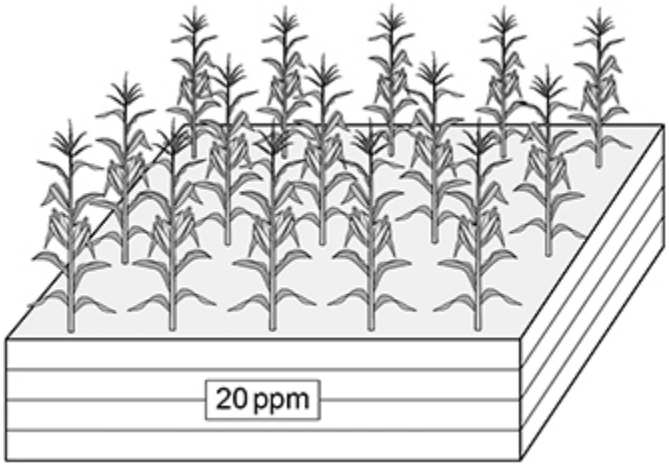
5. Scientists investigated the effect of soil nitrate ion concentration on the yield of corn.

This is the method used.

1. Corn plants were grown in a large box of soil.
2. The soil nitrate ion concentration in the box was kept at 0 parts per million (ppm).
3. All the corn from each plant in the box was removed and weighed.
4. The mean mass of corn per plant was calculated.
5. Steps 1 to 4 were repeated for boxes containing soil with different concentrations of nitrate ions.

Figure 1 shows the corn plants in the box with a 20 ppm soil nitrate ion concentration.

Figure 1



(a) Give **two** variables the scientists should have controlled in this investigation.

1 _____

_____

2 _____

_____

(2)

The scientists carried out a valid investigation.

The table below shows the scientists' results.

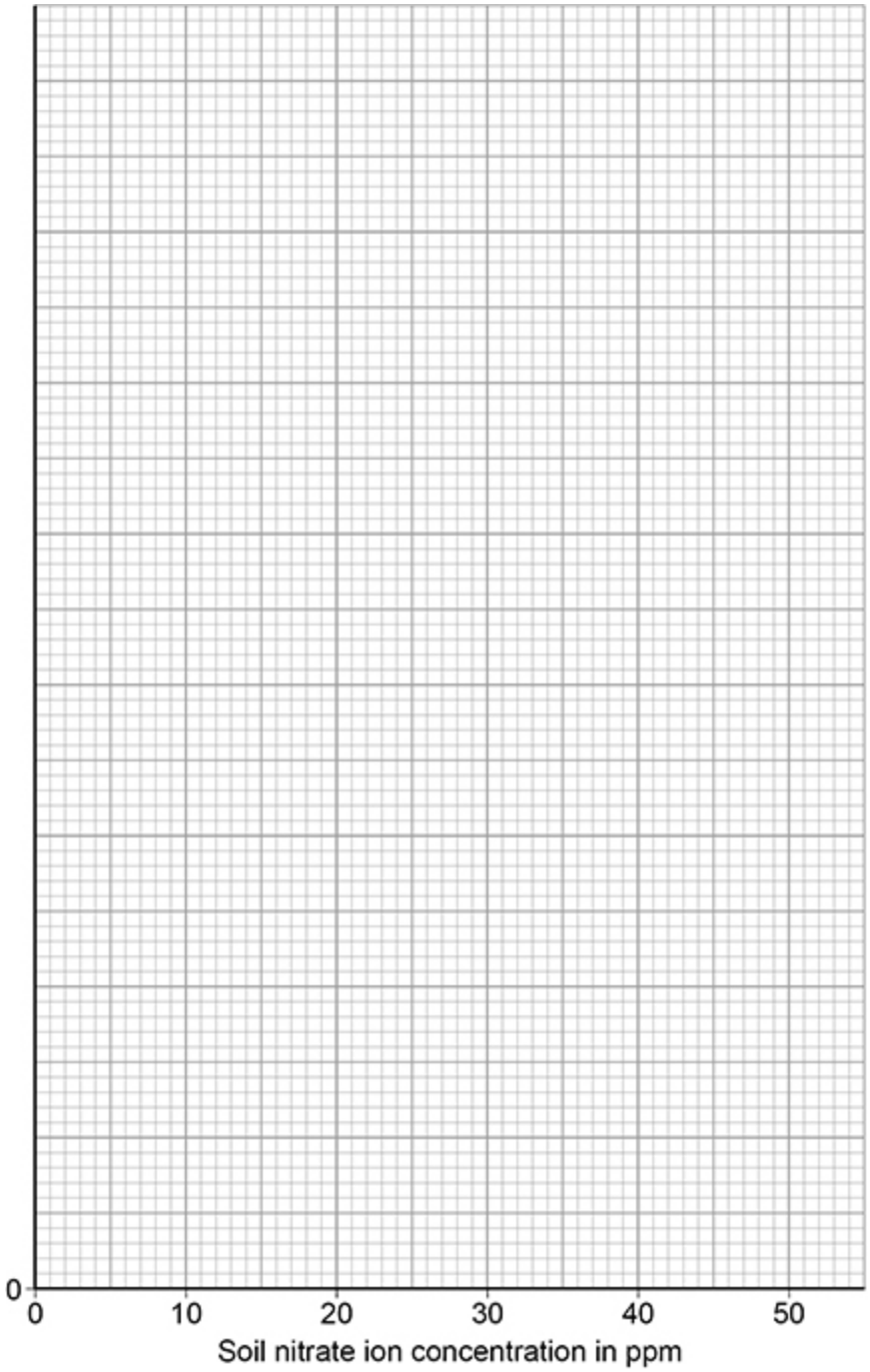
Soil nitrate ion concentration in ppm	**Mean mass of corn per plant in grams**
0	122
10	190
20	256
30	268
40	240
50	184

(b) Complete **Figure 2**.

You should:

- label the *y*-axis
- use a suitable scale for the *y*-axis
- plot the data from the table above
- draw a line of best fit.

Figure 2



(4)

The table above is repeated below.

Soil nitrate ion concentration in ppm	Mean mass of corn per plant in grams
0	122
10	190
20	256
30	268
40	240
50	184

(c) Describe the relationship between soil nitrate ion concentration and the mean mass of corn per plant.

Use data from the table above in your answer.

_____

_____

_____

_____

(2)

(d) Farmers add nitrate fertiliser to fields where they grow corn.

Nitrate fertilisers are expensive.

Evaluate the economic and environmental implications of adding fertiliser to soil in nitrate ion concentrations ranging from 0 to 50 ppm

(4)

(Total 12 marks)

6. Caffeine is a drug that affects reaction time.

Coffee is a drink that contains caffeine.

Five students investigated the effect of drinking coffee on their reaction time.

Each student sat in front of a computer screen showing a reaction timer.

This is the method used.

1. Press any key on the keyboard when the colour of the screen changes to green.
2. Record the reaction time shown on the computer screen.
3. Drink coffee containing caffeine.
4. Wait 15 minutes then repeat steps 1 and 2.

(a) What is the dependent variable in the investigation?

Tick (✓) **one** box.

The coffee containing caffeine ☐

The number of students ☐

The reaction time ☐

(1)

(b) Give **two** control variables the students should have used.

1 _____

_____

2 _____

_____

(2)

(c) Why did the students wait 15 minutes after drinking the coffee before repeating the test?

_____

_____

(1)

(d) Responding to the colour change of the screen involves a receptor in the student.

Where is the receptor in the student?

Tick (✓) **one** box.

Ear ☐

Eye ☐

Skin ☐

(1)

(e) Responding to the colour change of the screen involves an effector in the student.

What is the effector in the student?

Tick (✓) **one** box.

Brain ☐

Gland ☐

Muscle ☐

Spinal cord ☐

(1)

The table below shows the results.

Student	**Reaction time in milliseconds**	
	Before drinking coffee	**After drinking coffee**
1	385	255
2	420	291
3	285	265
4	871	259
5	463	247

(f) What is the effect of drinking coffee on reaction time?

Use the table above.

_____

_____

(1)

(g) Which student had the smallest change in reaction time after drinking coffee?

Tick (✓) **one** box.

Student 1 ☐

Student 2 ☐

Student 3 ☐

Student 4 ☐

Student 5 ☐

(1)

(h) The students decided that one of the results was anomalous.

What should the students do with the anomalous result when calculating the mean change in reaction time?

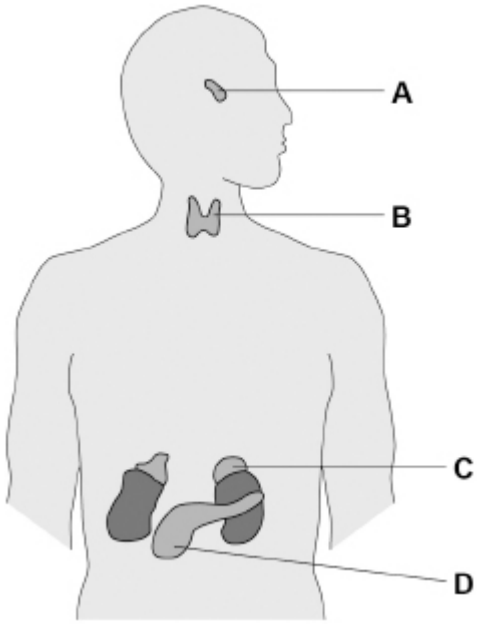
_____

_____

(1)

(Total 9 marks)

7. The figure below shows glands in the human body.



(a) Which organ system includes the glands shown in the figure above?

_____

(1)

(b) Which gland produces insulin?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(c) Which gland produces hormones that stimulate the other glands to produce hormones?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(d) How do hormones travel from one gland to another gland?

_____

_____

(1)

(e) Name **two** glands involved in human reproduction.

Do **not** refer to glands shown on the figure above in your answer.

1 _____

2 _____

(2)

(f) Ovulation test kits can help women know when they are most fertile.

Ovulation test kits detect the increase in the hormone that stimulates ovulation.

Which hormone is detected by ovulation test kits?

Tick (✓) **one** box.

- Follicle stimulating hormone (FSH) ☐
- Luteinising hormone (LH) ☐
- Oestrogen ☐
- Progesterone ☐

(1)

(g) A new contraceptive drug for men is being tested.

The drug:

- is given in one injection
- stops sperm being able to fertilise eggs
- is effective for up to 13 years.

Evaluate the use of the new drug compared with existing contraceptive methods.

(6)

(Total 13 marks)

1.

(a) (more) thyroxine secreted / released

allow (more) thyroxine is produced / made / created

1

from thyroid (gland)

alternative answer
(more) adrenaline secreted / released / produced / made / created
(1) from adrenal gland (1)

1

(b) **Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

5–6

Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.

3–4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1–2

No relevant content

0

Indicative content

trends

- percentage of population with resistance increased for 6 months
  or
  percentage of population with resistance increased when warfarin was given
- then decreased after warfarin stopped being given
- the decrease is slower than the increase
- the change from increase to decrease is not instant (when warfarin stops being given at 6 months)
- manipulated figures

increase explanations

- some rats have allele(s) / gene(s) for resistance to warfarin
- this is due to (random) mutation(s)
- (therefore) more likely to survive if warfarin is being used
- rats with resistance reproduce
- passing on allele / gene (for resistance) to next generation
- repeats for several / many generations until all / most of population is resistant
- several generations within 6 months

decrease explanations

- when warfarin is not used, rats with resistance are outcompeted for food / mates / territory / shelter by non-resistant rats
- rats with resistance are killed by larger non-resistant rats
- (therefore) rats without resistance become more likely to reproduce

For **Level 3**, answers must explain increase **and** decrease in percentage of population resistant to warfarin.

[8]

2. (a)

Variable	Independent variable	Dependent variable	Control variable
Distractions from background sounds			✓
Reaction time		✓	
Type of stimulus	✓		

*do **not** accept more than one tick in any row*

3

(b) repeat both methods 10 times

1

(c) any **one** from:

- practice

  ignore repeating
- fewer distractions
- familiarity (with test)

  allow reference to effect of caffeine

  allow answers referring to competitiveness

  eg the student wanted to beat a previous time

1

(d) 2 bars correctly plotted

and

2 bars correctly labelled as seeing (the stimulus) and hearing (the stimulus)

allow a tolerance of ± ½ a small square

allow any width bars touching or not

allow bars in either order

1

(y axis label) (mean reaction) time in milliseconds / ms

1

(e) (when seeing stimulus reaction time is) longer / greater / higher

allow converse for hearing stimulus if clearly stated

allow bigger / larger

allow slower (reaction time)

allow slower (reactions)

allow 130 milliseconds more

ignore 130 milliseconds unqualified

1

[8]

3. (a) any **one** from:

- blood glucose / sugar (concentration)
- water (content of the body)

allow pH

allow ions / salt

allow carbon dioxide

allow oxygen

allow blood pressure

1

(b) to maintain (temperature close to) optimum / optimal conditions / temperature

1

for enzyme action

allow for cells to function

allow for reactions in cells

*allow for **2** marks enzymes have an optimum temperature*

1

(c) $\frac{37.0 - 35.5}{4}$

allow $\frac{1.5}{4}$

1

0.375 (°C per hour)

*allow 0.4 **or** 0.38 (°C per hour) ignore minus sign*

1

(d) $37 \times \frac{5.5}{100}$

allow 37 × 0.055

1

2.035 (°C)

1

(37 - 2.035 =) 34.965

allow 34.97

1

35 (°C)

allow an incorrectly calculated temperature given correctly to 2 significant figures

*do **not** accept 35.0 (°C)*

1

alternative method:

$1 - \frac{5.5}{100}$ (1)

0.945 (1)

(37 × 0.945 =) 34.965 (1)

allow 34.97

35 (°C) (1)

allow an incorrectly calculated temperature given correctly to 2 significant figures

*do **not** accept 35.0 (°C)*

(e) pituitary (gland)

1

(f) (adrenal glands) release / produce adrenaline

1

(to) increase heart rate

1

(so) more / faster delivery of oxygen **and** glucose to brain / muscles

1

(because) more oxygen / glucose needed for respiration

1

to move muscles to increase body temperature
or
to release energy / heat to increase body temperature

allow for shivering to increase body temperature
*do **not** accept energy is made / produced / created*

ignore flight or fight

1

(g) (decreasing body temperature causes thyroid gland to) release / produce thyroxine

1

(which) increases / stimulates (basal) metabolic rate

allow (which) increases metabolism
allow (which) increases respiration
allow (which) increases reactions in cells

1

(so) increasing body temperature which decreases the release / production of thyroxine

1

[18]

4. (a) D

1

(b) B

1

(c) (in / through / via) blood(stream)

allow (in / through / via) plasma
allow (in / through / via) blood vessels
allow (in / through / via) arteries / veins / capillaries

1

(d) insulin

1

(e) glucose is converted to glycogen

1

glucose moves from the blood into the cells

1

(f) 8:30 (am)

allow 8:25 – 8:35 (am)

allow time written in words

1

(g) any value in the range ≥ 6.5 to ≤ 20 (mmol/dm^3)

1

(h) any **two** from:

- low carbohydrate diet

  allow low calorie / fat / sugar diet

  allow eat fewer (sugary) snacks

- exercise (regime)

  allow description of exercise

- lose body mass

  allow lose weight

  allow (metformin) tablets to reduce blood glucose

2

(i) (less) respiration

1

(so) less energy released / transferred

*do **not** accept energy produced / made / created*

or

less muscle contraction

1

[12]

5.

(a) any **two** from:

- light (intensity)
- water
- temperature
- mass / volume of soil

allow size of box

allow depth of soil

- soil type **or** (soil) pH
- other mineral content of the soil

ignore fertiliser

- number of plants (in a box)

allow planting density

- starting mass / height / age of corn
- type / variety of corn

allow species of corn

- harvested at the same time

allow harvested when mature

2

*do **not** accept nitrate ion concentration*

(b) suitable scale **and** axis labelled (mean mass (of corn) per plant in grams / g)

1

all points plotted correctly

allow a tolerance of ± ½ a small square

*allow **1** mark for 4 or 5 correct plots*

2

suitable line of best fit

ignore line extended beyond 50ppm

ignore line joined point to point with straight lines

1

*max **3** marks for bar chart*

(c) as (soil) nitrate / concentration increases, (mean) mass (of corn) increases **and** then decreases

1

with a maximum (mean mass of corn) at 30 (ppm)

*allow a maximum consistent with graph in part **(b)***

1

*if no other mark awarded, allow **1** mark for (mean mass of corn) increases to 30 (ppm) **or** (mean mass of corn) decreases above 30 (ppm)*

(d) any **four** from:
(economic)

- increasing nitrate / ion (concentration) up to 30 ppm will give high(er) yield / income / sales

  ignore mass for this marking point only

- greater than 30 ppm will decrease yield / mass / income / sales **and** therefore waste money / fertiliser

  *allow greater than 30 ppm, the yield / mass / income / sales / will not increase (as much) **and** therefore waste money / fertiliser*

- any increase in yield / mass / income / sales must be balanced with cost (of fertiliser)

  *allow profit / benefit will depend on yield / mass / income / sales **and** cost (of fertiliser)*

- quantity to add will depend on original nitrate (ion concentration) of soil

(environmental)

- (when it rains) fertiliser / nitrate will enter rivers / lakes / sea / ocean causing pollution

  allow fertiliser / nitrate run-off causes pollution

  allow eutrophication or description of eutrophication

  allow description of effect of fertiliser / nitrate pollution eg health impact of fertiliser in drinking water

  allow environmental implication of (significant) energy use in fertiliser production / transport

  *max **3** marks if no reference to environmental implication*

4

[12]

6. (a) the reaction time

1

(b) any **two** from:

- age
- sex

  allow gender
- previous intake of caffeine / coffee that day
- usual intake of caffeine / coffee (on previous days)
- concentration of caffeine / coffee
- volume of caffeine / coffee

  if neither given allow amount / mass of caffeine / drink ***or*** *type / brand of coffee for* ***1*** *mark*
- time of day
- amount / length of sleep

  allow fatigue
- health

  allow other drugs taken
- body mass

  allow (body) weight
- same / type of reaction time program / software
- same keyboard
- prior experience with the reaction timer

2

(c) any **one** from:

- (time) for the coffee / caffeine to work
- (time) for coffee / caffeine to be absorbed

  allow (time) for the coffee / caffeine to be digested
- (time) for caffeine to reach the brain

  allow (time) for coffee to reach the brain
- (time) for coffee / caffeine to get round the body

1

(d) eye

1

(e) muscle

1

(f) (reaction time is) decreased

allow reaction time is shorter

allow reactions are faster

allow (reaction) time is quicker

1

(g) student 3

1

(h) leave it out (and divide sum of the others by 4)

or

divide the sum of the others by 4

ignore repeat the test

1

[9]

7.

(a) endocrine (system)

ignore hormonal (system)

1

(b) D

1

(c) A

1

(d) (in / through / via) blood

allow (in / through / via) bloodstream

allow (in / through / via) plasma

*allow (in / through / via) blood vessels **or** named blood vessel*

1

(e) ovary / ovaries

in either order

1

testis / testes

allow testicle(s)

allow placenta

*if no other mark awarded allow gonad(s) for **1** mark*

1

(f) luteinising hormone (LH)

1

(g) **Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.

5–6

Level 2: Some logically linked reasons are given. There may also be a simple judgement.

3–4

Level 1: Relevant points are made. They are not logically linked. 1–2

1–2

No relevant content

0

Indicative content

Advantages

- non-permanent like condom / diaphragm / IUDs / spermicides / abstinence **or** unlike surgical sterilisation
- longer lasting than condom / diaphragm / IUDs / spermicides
- no need to remember unlike oral contraceptive
- one injection rather than surgery for sterilisation
- surgery (for sterilisation) has risks, for example, infection
- no other method of long-lasting contraception (rather than sterilisation) relies on men

Disadvantages

- no protection from sexually transmitted diseases unlike barrier methods **or** named barrier method
- not as long lasting as (surgical) sterilisation
- at clinical / drug trial stage, so unknown side effects
- at clinical / drug trial stage, so unknown efficacy
- do not know how long it will last (as info only states ‘up to 13 years’)
- can stop taking a pill **or** using a condom if you change your mind / want to get pregnant, whereas have to wait 13 years with the injection
- (minor) risk of infection posed with an injection compared to no risk with the oral contraceptive

For **Level 3** references to advantages **and** disadvantages of the new drug compared to named existing methods are required.

[13]