

Internal Assessment Resource

Biology Level 3

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| This resource supports assessment against:  Achievement Standard 91604  Demonstrate understanding of how an animal maintains a stable internal environment |
| Resource title: Coast to Coast |
| 3 credits |
| This resource:   * Clarifies the requirements of the standard * Supports good assessment practice * Should be subjected to the school’s usual assessment quality assurance process * Should be modified to make the context relevant to students in their school environment and ensure that submitted evidence is authentic |

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| Date version published by Ministry of Education | March 2025  To support internal assessment from 2025 |
| Authenticity of evidence | Teachers must manage authenticity for any assessment from a public source, because students may have access to the assessment schedule or student exemplar material.  Using this assessment resource without modification may mean that students’ work is not authentic. The teacher may need to change figures, measurements or data sources or set a different context or topic to be investigated or a different text to read or perform. |

**Internal Assessment Resource**

Achievement Standard Biology 91604: Demonstrate understanding of how an animal maintains a stable internal environment

Resource reference: Biology 3.4A

Resource title: Coast to Coast

Credits: 3

Teacher guidelines

The following guidelines are supplied to enable teachers to carry out valid and consistent assessment using this internal assessment resource.

Teachers need to be very familiar with the outcome being assessed by Achievement Standard Biology 91604. The achievement criteria and the explanatory notes contain information, definitions, and requirements that are crucial when interpreting the standard and assessing students against it.

Context/setting

The task involves students demonstrating an understanding of a homeostatic control system and how it functions to maintain a stable internal environment despite fluctuating environmental conditions. This includes the biological ideas related to the purpose, components, and mechanisms of the thermoregulatory control system in a human athlete. It also includes describing the potential effect of disruption to the system by internal or external influences.

Students are asked to explain the biological ideas related to the purpose, components, and mechanisms of the human thermoregulatory system. This involves describing how the system incorporates components, and explaining how the system responds to a range of external conditions in a scenario related to extreme environmental conditions (i.e. weather). Students are also asked to explain how a specific disruption results in responses within the control system to re-establish a stable internal environment.

To demonstrate comprehensive understanding, they must link biological ideas about maintaining a stable internal environment in an athlete, including a discussion of the adaptive significance of the control system, OR a discussion of the biochemical and/or biophysical processes underpinning the mechanism, OR an analysis of a specific example of a breakdown of the control system.

Other possible contexts include:

* osmoregulation in a euryhaline New Zealand fish species
* blood glucose levels in a Type 1 or Type 2 diabetic
* respiratory gas levels in tissues of a marathon runner during the run
* manipulation of reproductive cycles in dairy cows to enhance milk production.

Before modifying this resource in another context the teacher should select/finalise/negotiate a context that will engage their students, plan exactly how the assessment is applied to this context, create or finalise any student pages that are needed (e.g. possible negative feedback models), and ensure that the examples of evidence in the assessment schedule align with the task in its final form.

Conditions

It is suggested that assessment takes place over approximately 4 hours; this allows for up to 30 minutes group discussion and at least 3 hours individual work.

Facilitate a preliminary group discussion of the scenario resource(s) to identify aspects relevant to control systems in humans. Students may take notes during the discussion, but you should not have direct input at any stage.

Students work independently to produce their final report using only the provided resources. Resources used should be processed into the students’ own words and should be included with the report as evidence of processing.

The final report could include evidence in written, visual, or electronic form or a constructed model. The diagram or model could be produced using an appropriate computer program/software.

Assessors must monitor the process of evidence collection to ensure authenticity, for example by regularly discussing student evidence or using checkpoints or milestones.

Resource requirements

Stimulus material in the scenario could include route plans and topographical maps, weather forecasts, event programme, etc. These must be used **in support of** demonstrating an understanding of a homeostatic control system.

Access to computers may be required.

Additional information

Prior learning should incorporate the indicators from *The New Zealand Curriculum* Level 8 Science Living World achievement objective on Life Processes, Ecology and Evolution: ‘Understand the relationship between organisms and their environment’, related to the material in the Teaching and Learning Guide for Biology, Ministry of Education, at [TKI - Biology](https://seniorsecondary.tki.org.nz/index.php/Science/Biology).

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Achievement Standard Biology 91604: Demonstrate understanding of how an animal maintains a stable internal environment

Resource reference: Biology 3.4A

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| Achievement | Achievement with Merit | Achievement with Excellence |
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| Demonstrate understanding of how an animal maintains a stable internal environment. | Demonstrate in-depth understanding of how an animal maintains a stable internal environment. | Demonstrate comprehensive understanding of how an animal maintains a stable internal environment. |

Student instructions

Introduction

This assessment activity requires you to write a report that describes thermoregulation, and how it works to enable an athlete competing in the ‘Coast to Coast’ event to maintain a stable internal environment, despite fluctuating environmental conditions. This will involve describing the purpose, components, and mechanisms of the system and explaining how they work together. Although environmental conditions will be part of your description, the focus of this assessment is on the internal biological processes of homeostasis.

You will be assessed on the comprehensiveness of your report and the extent to which you link biological ideas about maintaining a stable internal environment in an animal.

Your teacher will facilitate a preliminary group discussion of the resource materials provided, to identify aspects relevant to your task. It would be useful to make notes during the discussion time.

Teacher note: Select a time frame that suits you and your students, ensuring they have enough time to complete the assessment. Specify milestone points to monitor progress and a due date.

Work independently to produce the report using only the resources provided. No additional resource material or references should be brought into writing sessions, although you may carry out additional research to enhance your understanding of thermoregulatory control systems in humans between report-writing sessions.

Your report could include evidence in written, visual, or electronic form, or a constructed model. For example, a diagram or model could be produced using an appropriate computer program/software.

You have 4 hours to analyse the scenario given in the task below and to produce your report.

Task

Working individually, **review the scenario** (Student Resource A below) for an athlete competing in the ‘Coast to Coast’ event in the South Island of New Zealand.

Use the above information, and any notes from the preliminary group discussion, to produce a report on the biological ideas related to the thermoregulatory homeostatic control system for the athlete to maintain a stable internal environment.

Include in your report:

* a description of the *purpose and components* of this homeostatic control system, which may include annotated diagrams or models
* an explanation of the *mechanism* of this control system, i.e. how it responds to the normal range of environmental fluctuations, the interaction and feedback mechanisms between parts of the system
* an explanationof how balance is re-established following the potential effect of one specific disruption to this control system by internal or external influences (e.g. extreme environmental conditions, disease or infection, drugs or toxins, genetic conditions, or metabolic disorders) in the scenario below (Student Resource A).

In your report,link biological ideas about maintaining a stable internal environment for any one of the following:

* a discussion of the adaptive significance of this control system
* a discussion of the biochemical and/or biophysical processes underpinning the mechanism of this control system (e.g. equilibrium reactions, changes in membrane permeability, metabolic pathways)
* an analysis of a specific example of how external and/or internal environmental influences (e.g. extreme environmental conditions, disease or infection, drugs or toxins, genetic conditions, or metabolic disorders) may result in a breakdown of this control system.

Student Resource A

Longest Day ‘Coast to Coast’ Multisport Event

The ‘Coast to Coast’ is a mountain race held annually in the South Island of New Zealand. Participants begin at Kumara on the West Coast, run, kayak, and cycle their way over the Main Divide on their way to Sumner Beach on the east coast near Christchurch. They cross a variety of terrain and are exposed to a wide range of weather and track conditions as they complete the ‘Longest Day’. The race begins at 6am. First arrivals in the [one-day](http://www.coasttocoast.co.nz/program.htm) event usually reach Sumner about 11 hours later, with most arriving 3 to 4 hours after that. Expected total time from start to finish is in the range of 11 to 17 hours.

Competitors have to manage their personal physical environment throughout the event to avoid problems such as heat stroke or heat exhaustion due to biological stress. This could include managing fluid and food intake, clothing, and equipment.

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| **Stage description** | **Local conditions** | **Map** |
| Stage One (5am assembly)  A 3km run followed by 55km cycle on sealed roads, gaining 500m elevation over the distance, reaching the Aickens transition:   * expected time of 1.5 to 2.5 hours * typical fluid intake of 1-2 litres. | Stage One  Temperature 14**°**C  Wind speed 5km/h  No rain | Include profile map of stages from ‘Coast to Coast’ website  [www.coasttocoast.co.nz](http://www.coasttocoast.co.nz) |
| Stage Two  With a day pack, a 33km mountain run, along mountain tracks, through rivers, up riverbeds with some off-track running, cross Goat Pass at 1100m, and down into Mingha riverbed, cross Bealey River and run to Klondyke Corner:   * expected time of 3 to 8 hours * typical fluid intake of 4-5 litres. | Stage Two  Temperature drops to -3**°**C at Goat Pass  Wind speed 30km/h  Hail and rain | Goat Pass  Klondyke Corner  Aickens |
| Stage Three  Cycle 15km on road, carrying warm clothing, 800m run down to 67km kayaking section, wearing kayak helmet through 25km flat braided river, followed by 25km gorge with Grade 2 rapids then 17km flat kayaking:   * expected time of 4 to 8 hours * typical fluid intake of 3 litres. | Stage Three  Temperature 16°C  Wind speed blustery gusts to 45km/h  Cloudy, rain stopped | 25km easy  25km in narrow gorge rapids  67km total |
| Stage Four  Cycle 70km from Waimakariri Gorge to Sumner Beach on roads (road falls 250m over this section):   * typical fluid intake of 5 litres. | Stage Four  Temperature rising to 35C  Wind speed gusts to 60km/h  No rain, clear skies | Gorge Bridge  70km  Sumner |

Assessment schedule: Biology 91604 Coast to Coast

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| Evidence/Judgements for Achievement | Evidence/Judgements for Achievement with Merit | Evidence/Judgements for Achievement with Excellence |
| The student demonstrates understanding using biological ideas to **describe** a control system by which a human in the scenario maintains a stable internal environment, including the:   * purpose * components * mechanisms * potential effect of disruption of the thermoregulatory homeostatic control system.   *Annotated diagrams or models may be used to support the description.*  The student demonstrates understanding of the internal control systems for maintaining stable internal body temperature **in response to a normal range** of environmental fluctuations.  For example:  *The key components of the human thermoregulatory homeostatic control system include the skin, the sweat glands, the hypothalamus and the circulatory system. Within the skin there are mechanisms such as the peripheral thermoreceptors that send neuronal signals to the hypothalamus to indicate the external temperature of the body. Central thermoreceptors in the core also send neuronal signals to the hypothalamus indicating the internal temperature of the body. The components of the thermoregulatory system work together in a negative feedback loop in order to maintain a safe body temperature of about 37סC. The reason for maintaining this temperature is to ensure chemical reactions within the body occur at their optimum rate for cellular function. For example, an athlete competing in Coast to Coast will need to sustain a high rate of cellular respiration in their skeletal muscles. Glucose is metabolised through the process of glycolysis to release ATP in the muscles. The enzyme hexokinase starts the process of glycolysis. At low temperatures the rate of the reaction catalysed by hexokinase would be too slow, at higher temperatures the rate would increase until the active site of the enzyme starts to denature from the heat. At this point there would not be enough ATP produced through glycolysis to sustain a high level of athletic performance. Eventually, if the internal body temperature was not regulated back to 37סC the athlete would experience the effects of hypoglycemia throughout their entire body including dizziness, confusion, cardiac stress, and eventually, death.*  *Under normal conditions, to maintain an optimum temperature for chemical reactions in the body, the hypothalamus will control the diameter of arterioles by…*  ***[student also includes a description of the components and mechanisms of thermoregulation system and how it responds to the normal range of environmental fluctuations, interactions and feedback mechanisms between parts of the system]***  ***The examples above relate to only part of what is required, and are just indicative.*** | The student demonstratesin-depth understanding using biological ideas to **explain how** a human in the scenario maintains a stable internal environment by including the:   * purpose * components * mechanisms * potential effect of disruption of the thermoregulatory homeostatic control system.   *Annotated diagrams or models may be used to support the explanation.*  The student also uses the scenario to demonstrate how balance isre-established **following one specific disruption**to this homeostatic system.  For example:  *As the athlete cycles uphill in Stage One, their body temperature is likely to rise above 37סC because the major leg muscles are respiring at a higher rate than normal. This releases additional heat within the muscle tissue and disrupts the normal process of thermoregulation because more heat is being produced than can be dissipated through control of vasodilation alone. Blood collects and circulates the extra heat from the muscles, which begins to increase the core body temperature.*  *The thermoreceptors in the core of the body send a neuronal signal to the brain where the anterior hypothalamus detects the increased body temperature and initiates the negative feedback response.*  *It sends a nervous impulse to dilate the smooth muscle of the cutaneous blood vessels, and to the eccrine sweat glands in the skin, so the athlete will start to sweat. The combination of increase blood volume in the skin, and the excretion of sweat, will result in an increased rate of thermal transfer from the blood to the surface of the skin. Because the temperature surrounding the athlete in Stage one is 14 סC and there is no rain, heat energy can be lost through both thermal radiation and evaporative cooling, lowering the temperature of the blood and therefore the body.*  *Once the core body temperature has returned to 37סC the thermoreceptors in the core of the body (including the abdomen and oesophagus) will send a nerve signal to the hypothalamus, which will signal the eccrine sweat glands to stop their excretions, and signal to the smooth muscle in the arterioles to contract, reducing the flow of blood to the extremities, and reducing the rate of heat loss to the environment…*  ***[student also includes an explanation of the purpose of the thermoregulation system and how it responds to the normal range of environmental fluctuations, interactions and feedback mechanisms between parts of the system]***  ***The examples above relate to only part of what is required, and are just indicative.*** | The student demonstrates comprehensive understanding of **how** a human in the scenario maintains a stable internal environment by **linking** biological ideas of the:   * purpose * components * mechanisms * potential effect of disruption of the thermoregulatory homeostatic control system.   *Annotated diagrams or models may be used to support the linked discussion.*  The student’s response also includes at least **one of**:   * a discussion of the **adaptive significance** of the control system * a discussion of the biochemical and/or biophysical **processes** underpinning the mechanism (such as equilibrium reactions, changes in membrane permeability, metabolic pathways) * an analysis of a specific example of how external and/or internal environmental influences result in a **breakdown** of the control system such as extreme environmental conditions, disease or infection, drugs or toxins, genetic conditions, or metabolic disorders.   For example:  *A specific breakdown of the thermoregulatory control system during the Coast to Coast race could occur if dehydration prevents the sweating response from activating to cool the athlete down. Athletes in the Coast to Coast race will produce a lot of body heat as a by-product of respiration in their skeletal muscles. To maintain internal temperature their hypothalamus will signal the body to dilate arterioles and capillaries, and produce sweat.*  *For this physiological response to be effective, the athlete must wear clothing that allows sweat to evaporate from the body. If the athlete is wearing an insulating layer of clothing, the mechanism of thermal radiation from the skin will not occur because surrounding humidity and temperature both affect the efficacy of sweating as a response for heat transfer away from the body. If sweat cannot evaporate from the skin, the heat energy transferred from the blood to the sweat will not leave the surface of the skin and the body temperature will not reduce.*  *If the athlete is wearing breathable clothing but has not consumed enough water, there will not be enough water reserves in the dermis for sweat to be excreted. This is why in the table of data provided, the average consumption of water was highest in Stage 2 and Stage 4. In Stage 2 the athlete is running up a steep incline and the rate of cellular respiration in their skeletal muscle will increase in response to the challenging terrain. Athletes consume on average 4-5 litres of water during this stage of the race because they will be excreting the water in the form of sweat as part of their thermoregulatory response to internal temperature increases. The increased consumption of water reflects the increased fluid required for sweat production…*  *For athletes who are sweating excessively but not replacing their water loss, dehydration will lead to a decreased blood volume. This in turn will cause decreased blood pressure and dizziness or fainting. In extreme cases, a dehydrated athlete could experience heatstroke, which includes dry, hot skin and central nervous system abnormalities such as convulsions and coma. These symptoms are a physiological response to the combination of extreme heat affecting neurological signals, and dehydration affecting blood volume. Reduced blood volume can lead to hypovolemic shock, resulting in organ failure because there is not enough blood in the body to deliver oxygen to essential organs for cellular respiration.*    *Apart from encapsulating clothing, barriers to sweat-based cooling include disorders such as hypohidrosis or anhidrosis. These could be caused by conditions that affect the function of components of the thermoregulation system, including nerve damage caused by diabetes or skin damage from burns. People who are unable to thermoregulate because of disease or injury will need to manage their physical activity and environment so that they are not exposed to extreme fluctuations in temperature.*  ***[student response also includes discussion linking the components, mechanisms, and purpose of thermoregulation, and how the body may be affected by a disruption]***  ***The examples above relate to only part of what is required, and are just indicative.*** |

Final grades will be decided using professional judgement based on a holistic examination of the evidence provided against the criteria in the Achievement Standard.