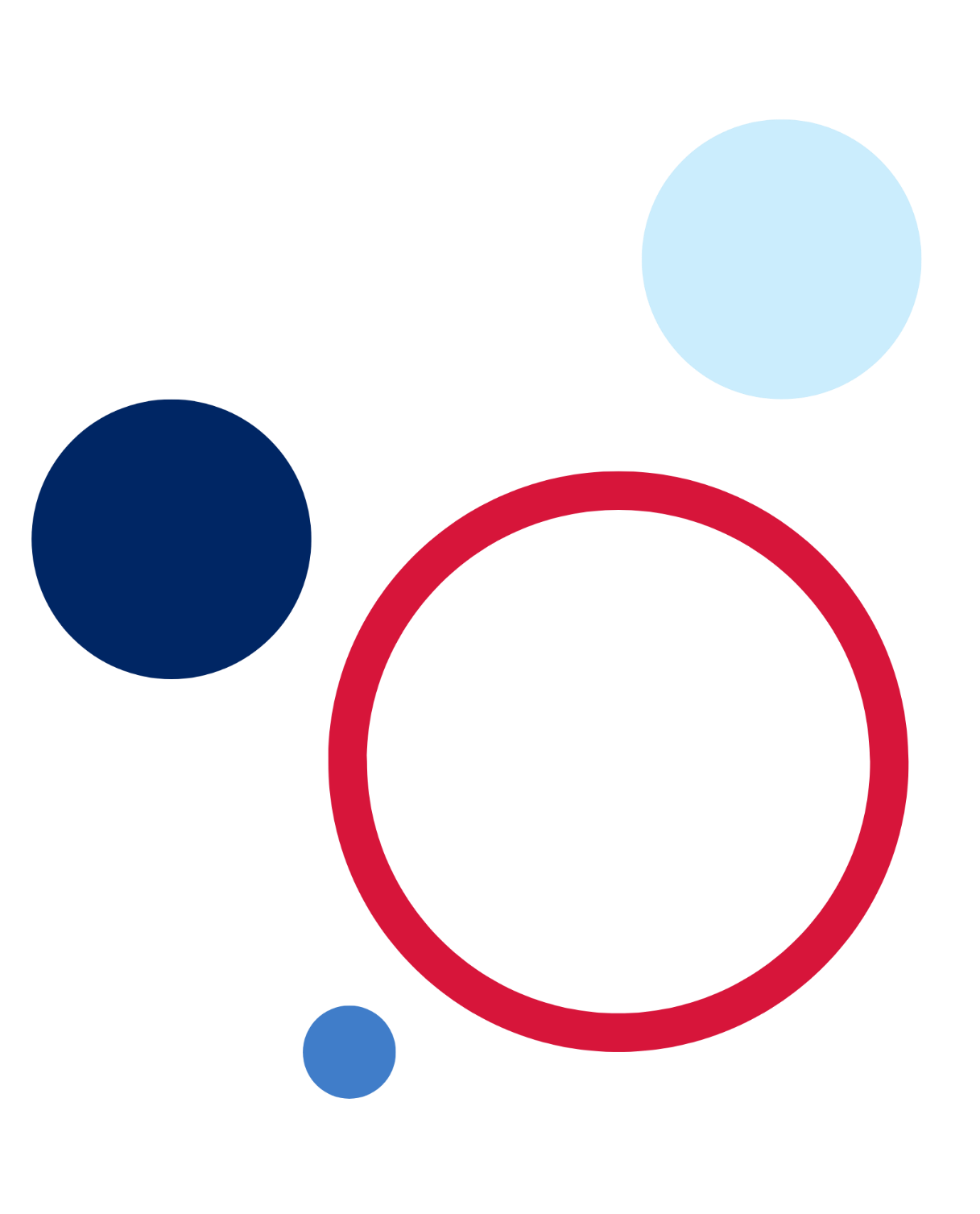
# Science Extension Stage 6 – using student research reports to improve student writing



## Overview

**Stage and Learning Area**: Science Extension Stage 6

**Description**: this resource aims to support Science Extension students in completing their Scientific Research Project in Module 4, focusing on improving report writing skills. Examples of Student Research Reports are used as model texts to illustrate scientific research reports' purpose, structure and language features.

**When to use this resource**: this resource can help students with their Student Research Project at different stages. There are 2 activities – Activity 1 and Activity 2 – that can help students improve their writing skills for science. These activities can be used when planning their research report or before they start reading other research articles. You can use one or both activities to meet your students’ needs.

While timing will vary based on the mode of delivery, differentiation strategies employed and class or school context, this series of activities should take approximately 2–3 hours.

## Information for teachers

### Introduction

Writing and writing instruction: An overview of the literature (McLean and Griffiths 2022) outlines 3 key approaches to writing instruction:

1. **Writing as a product** – focuses on the final written work and emphasises the importance of structure, grammar, and mechanics.
2. **Writing as a process** – emphasises the stages of writing, such as prewriting, drafting, revising, and editing.
3. **Genre writing** – focuses on the conventions and expectations of specific writing genres, such as academic or creative writing.

The following activities use the genre writing approach to help students write better scientific papers. Genre writing means that the purpose of the writing is important, and it decides how the paper should be structured and written. This approach teaches the purpose, structure and language features by using model texts as examples (Martin and Rose 2005; Derewianka 2015). The learning sequence is designed to help students improve step by step. Teachers can change the task or focus on different parts depending on their class and how well the students understand the content.

This content also links with other sections of the Science Extension course, including:

* Scientific Research Project: How do scientists present a scientific research report?
* Module 2: What are the processes needed for developing a scientific research question and initial hypothesis?

### Outcomes

* **SE-3** interrogates relevant and valid peer-reviewed scientific research to develop a scientific research question, hypothesis, proposal and plan
* **SE-6** analyses and reports on a contemporary issue or an application of science informed by primary or secondary-sourced data, or both, in relation to relevant publicly available data sets
* **SE-7** communicates analysis of an argument or conclusion incorporating appropriate scientific language and referencing techniques in a scientific report

[Science Extension Stage 6 Syllabus](https://educationstandards.nsw.edu.au/wps/portal/nesa/11-12/stage-6-learning-areas/stage-6-science/science-extension-syllabus) © NSW Education Standards Authority (NESA) for and on behalf of the Crown in right of the State of New South Wales, 2017.

### Learning intentions and success criteria

Students will improve their understanding of the structure and features of a scientific research report.

Students:

* can identify the purpose, structure and language features of a scientific research report and its sections.
* will be able to analyse model texts to determine how their structure and language features are used to convey information.
* will be able to identify and apply appropriate scientific language and referencing techniques in their research report.

## Teaching and learning activities

### Activity 1 – deconstructing scientific reports

#### General approach

[Deconstruction (WiS Resource Hub)](https://schoolsnsw.sharepoint.com/sites/WiSresourcehub/SitePages/Deconstruction.aspx) – interrogating the different parts of a text and identifying how each contributes to shaping meaning and achieving the writer’s purpose.

1. **Select a mentor text**: choose a student report from the journal as a mentor text for this activity (each student should have their own copy to annotate).
2. Class discussion: ask students what and how questions about the selected student report to elicit responses about its grammatical and lexical features (examples are provided in Activity 1: Deconstructing scientific reports).

**Mentor texts** should be examples of effective, coherent scientific writing that provide clear and teachable illustrations of grammatical choices and how those choices shape the meaning. They should also be age and stage-appropriate.

#### Deconstructing a literature review

1. Review the purpose of common features in scientific texts and their purpose and audience (refer to Table 1).
2. Review any text features included in the text and discuss the various purposes and effects of using such features. Features included in the model text, and sample responses, are outlined in Table 2.
3. Advise students to use this table to analyse the effect of certain text features, not just identify the purpose. This could include how it positions the reader, how it makes the reader aware of added information, what it shows, or even how text features can help students make connections within and outside of texts.
4. Students use Table 3 – analysing the effect of text features to complete an analysis of text features in the literature review from a past HSC student’s Scientific Research Report (go to Activity 1: Deconstructing a literature review in the student resource section of this resource).
5. The teacher discusses student responses upon completion of the task.

Table 1 – what is the purpose of each of these components in the text?

|  |  |
| --- | --- |
| Component | Purpose |
| Title | Provides the essential information to inform your readers that they should keep reading. Supports readers in searching for and finding your work. |
| Abstract | The abstract provides a short, accurate representation of your research that readers will use to find and evaluate your work before reading the rest of your article. |
| Literature review | Clarifies your motivation for the work presented. |
| Tables and figures (photographs, diagrams, maps, graphs, flowcharts) | These visual representations help your readers to understand your field of research, methodology and/or research findings.  Tables and graphs help organise data to reveal trends and patterns in them. |
| Captions | Provide brief explanations of the images, diagrams, maps, or graphs. |
| Citations and footnotes | Acknowledge sources and provide additional information about the research. Citations also support your claims and arguments by providing credibility and authority. |
| Introductory paragraph | For example, the discussion provides the essential interpretations of the data and the main supporting evidence. |
| Body paragraphs | For example, in the discussion, they compare and contrast to previous studies, highlight the study’s strengths and limitations and discuss any unexpected findings. |
| Concluding paragraph | For example, the discussion discusses unanswered questions and potential future research. |

##### Sample response

Table 2 outlines sample student responses for Activity 1: Deconstructing a literature review. The teacher can use these responses to support a class discussion of text features after students have read the literature review.

Table 2 – sample responses for Activity 1 – deconstructing a literature review

|  |  |  |
| --- | --- | --- |
| Text feature | Explain its purpose | Analyse the effect of using this feature |
| Quoting statistics, for example, ‘10 million deaths’ | Used to emphasise the importance and enhance credibility. | This shows that the problems of cancer and physical inactivity are immense and worthy of attention. |
| Use of citations, including WHO and Matthewson | Used to add credibility and authority to claims and arguments. They also acknowledge sources and provide additional information about the research. | This makes the arguments made by the author more persuasive to the reader. In addition, the length of the literature review can be shorter and more succinct as the additional information in the cited sources is not included. |
| Subheadings | Used to guide the reader and help to break up the text into manageable sections. | This makes it easier for the reader to follow the complex ideas and arguments developed in the text. |
| The rhetorical question ‘Reverting the Warburg Effect?’ | Used to engage readers by prompting them to think critically about a topic or to challenge their assumptions. | This primes the reader to accept the potential for challenging the Warburg paradigm and encourages a positive view of the emerging research that is presented. |
| Scientific terminology and definitions. For example, ‘pyruvate: The end product of the enzymatic breakdown of glucose, known as glycolysis.’ | Terminology describes the biological processes and metabolic pathways related to cancer. In addition, definitions are provided to inform the reader about terms that may not be familiar to them. | Defining key terms allows readers without expert knowledge in this field of research to understand the research and its importance better. |
| Cohesive devices, including linking words and transitions. For example, phrases like ‘building on Warburg’s model’ and ‘however, it is important to note.’ | Used to connect ideas and improve the flow of the text. | In these examples, the linking words and transitions signal shifts in the argument and provide context for the reader. This improves the flow of the literature review, improving clarity and the reader’s understanding of the motivation for the investigation. |
| Introductory paragraph | Provides the context for the topic of research. | Introducing the statistics relating to cancer deaths and the ‘alarming, emerging studies’ relating exercise to cancers encourages the reader to continue reading by highlighting the importance of this field of research. |
| Concluding paragraph | Summarises the main points and implications of the research. | The gaps in the literature (quantitative studies) and the emerging evidence of lactate's potential impact on cancer cells summarise the arguments for the research and prepare readers to accept the importance of the Scientific Research Question. |

### Activity 2 – reading reports in and out of order

#### The general structure of a report

Most scientific papers are structured using the following sections:

* Abstract
* Introduction (in Science Extension, this section is subdivided into Literature review, Scientific research question, and Scientific hypothesis)
* Methodology
* Results
* Discussion
* Conclusion

#### Writing a research report

The sections of a research report are not generally written in the order presented in the finished report. For example, after completing data collection, students may begin writing their report by preparing the figures and tables used in their Scientific Research Report. This would be followed by the Methodology section, then the Results-Discussion-Conclusion sections. The literature review might be next, and then lastly, the abstract and title might be developed.

#### Reading a research report

Scientific reports are often not read from start to finish either. The article, [How to (seriously) read a scientific paper](https://www.science.org/content/article/how-seriously-read-scientific-paper) (Science 2016), outlines some of the different ways scientists at different career stages read scientific reports. For example

I start by reading the abstract. Then, I skim the introduction and flip through the article to look at the figures. I try to identify the most prominent one or two figures, and I really make sure I understand what's going on in them. Then, I read the conclusion/summary. Only when I have done that will I go back into the technical details to clarify any questions I might have.

– Jesse Shanahan, master's candidate in astronomy at Wesleyan University in Middletown, Connecticut

In this activity, students explore the features and purpose of the various sections of a scientific research report by reading the sections in a different order and reflecting on the approach that works best for them.

For novices without deep disciplinary knowledge, a preferred reading order could be:

* Abstract – to set the scene and provide an overview of the research.
* Introduction – to understand the motivation for the research and the problem or question being addressed.
* Skim the results including figures – to identify what the researchers discovered.
* Discussion and conclusion – to see how the results have been interpreted, including their implications and limitations.
* Then, go back and unpack the results.
* Finally, dive into the methodology if you have further questions.

### Student activity

1. Students, working individually or in pairs, select a student report from [The Journal of Science Extension Research – Vol. 2, 2023](https://issuu.com/doecurriculum/docs/journal_of_science_extension_research_vol_2_2023/s/21049152).
2. Each student begins reading their article in the order outlined above, annotating the report and/or taking notes as needed.
3. After reading the results, students are to identify the most important one or 2 figures and record their understanding of what they are showing.
4. After reading their report, each student or pair presents their identified figures and describes their understanding of the research.

**Inclusive practice:** guiding questions for each section of the report are included in Appendix 3. These can be used to support students in completing this activity. Alternatively, this activity could be completed as a teacher-led class task with each student reading and annotating the same student report. The WiS Resource Hub has further information for teachers on using a [supported reading](https://schoolsnsw.sharepoint.com/sites/WiSresourcehub/SitePages/Supported-Reading.aspx#modelled-reading-%E2%80%93-teacher-led) strategy to support student writing.

Encourage students to consider and trial some of the other approaches outlined in the Science article as they review the literature to support their Science Research Project.

[Supported reading (WiS)](https://schoolsnsw.sharepoint.com/sites/WiSresourcehub/SitePages/Supported-Reading.aspx) is the practice of sharing the experience of reading texts to support students’ decoding, comprehension, and deep learning of subject content and language skills. Note: this resource is only accessible to Department of Education staff.

The recommended strategy suggests focussing on mentor text of 100–500 words, so select a single section, such as the literature review.

This strategy aims to develop students who can read academic texts.

## Student resources

### Activity 1 – instructions for deconstructing reports

During deconstruction, teachers use the mentor text to work with students to identify the what and the how of the text. To identify the social purpose, or the what, discussion can focus on questions such as:

* What is the purpose of the text?
* Why are such texts used?
* Where are they found?
* Who uses them?

Once the social purpose is established, the discussion can move onto the how of the text:

* How is it organised and structured?
* How does it successfully use language to achieve its purpose for the identified audience and context?

This deconstruction process can be used to explore the scientific research report as a whole or explore the ‘what’ and ‘how’ of specific sections of the report.

The reports in the journals below were written by past HSC students and may make suitable mentor texts depending on the interests and capabilities of your students.

* [The Journal of Science Extension Research – Vol. 2, 2023](https://issuu.com/doecurriculum/docs/journal_of_science_extension_research_vol_2_2023)
* [The Journal of Science Extension Research – Vol. 1, 2022](https://issuu.com/doecurriculum/docs/journal_of_science_extension_research_vol_1_2022/s/17468063)

Alternatively, websites such as [Science Journals for Kids and Teens](https://www.sciencejournalforkids.org/articles/reading_level/high-school-upper/) have a wide range of accessible journal articles written at an appropriate level for high school students.

Further information and teaching resources on deconstruction are available on the [WiS Resource Hub](https://schoolsnsw.sharepoint.com/sites/WiSresourcehub/SitePages/Deconstruction.aspx).

#### What questions:

* What is the purpose of the research report?
* What is the research question or hypothesis being investigated?
* What is the methodology or experimental design used in the research?
* What are the key findings or results of the research?
* What are the limitations of the research, and how might they affect the interpretation of the results?
* What is the significance or potential impact of the research in the relevant field of study?
* What is the intended audience of the research report?
* What is the structure or organisation of the research report, and how does it contribute to the effectiveness of the communication?

#### How questions:

**How does the author use scientific terminology and jargon in the report?**

* Look for specialised terms and technical vocabulary specific to the field.
* Look for descriptions of experimental procedures, equipment, and measurements.
* Notice how the author defines and explains complex terms to ensure understanding within the scientific community.
* Pay attention to the consistent and accurate use of terminology throughout the report.

**How does the author use descriptive and technical language to communicate complex concepts to a specific audience?**

* Identify the use of detailed descriptions and explanations to convey complex concepts clearly and understandably.
* Look for analogies, metaphors, or visual language to make abstract concepts more relatable.
* Notice how the author breaks down complex ideas into simpler components and provides contextual examples for clarity.
* Pay attention to diagrams, illustrations, or models to support the explanation of complex concepts.

**How does the author use language to convey complex concepts and data?**

* Look for the precise and specific language used to describe experimental findings and data analysis.
* Identify how the author interprets and explains the significance of the data, drawing logical conclusions.
* Notice the use of statistical terms, mathematical equations, or formulae to present and analyse data accurately.

**How does the author use the passive and active voices in the report?**

* Notice the use of active voice to emphasise the subject performing an action, highlighting agency and clarity.
* Identify instances where the passive voice focuses on the action or creates a more formal tone.
* Pay attention to the consistent use of voice throughout the report to maintain clarity and coherence.

**How does the author use tense and verb forms to describe the research process and results?**

* Look for the use of past tense to describe methods, materials, and procedures employed in the research.
* Notice the use of the present tense when explaining general facts, principles, or established knowledge.
* Pay attention to the use of present or present perfect tense to describe results and findings that are still relevant.
* Identify specific verb forms used to convey degrees of certainty, such as modal verbs (can/might/must) or conditional forms (should/would/could).

**How does the author use citation and referencing to situate the research within the broader context of the field?**

* Look for in-text citations that acknowledge and refer to previous research relevant to the current study.
* Identify references to scholarly articles, books, or other reputable sources to support the claims made in the report.
* Notice the inclusion of a comprehensive reference list or bibliography at the end of the report.

**How does the author use visual aids such as graphs, tables, and figures to support the communication of the research findings?**

* Look for clear and well-labelled visual aids that effectively represent the data or findings.
* Identify the use of appropriate graph types, such as bar graphs, line graphs, or scatter plots, depending on the data being presented.
* Notice the use of legends, titles, and captions to provide necessary context and explanation for the visual aids.
* Pay attention to the integration of visual aids within the text to support and enhance the written communication.

**How does the author use sentence structure and syntax to convey meaning and emphasise key points?**

* Look for the use of varied sentence structures, such as complex or compound sentences, to convey relationships between ideas.
* Identify instances where parallel structure or repetition is used to emphasise key points or create a sense of rhythm.
* Notice the strategic placement of important information at the beginning or end of sentences for emphasis.

**How does the author use cohesive devices such as linking words and pronouns to connect ideas and create coherence in the report?**

* Look for linking words and phrases, such as ‘however’, ‘therefore’, or ‘in addition’, to connect ideas and create logical flow.
* Identify the use of pronouns, such as ‘it’, ‘this’, or ‘these’, to refer back to previously mentioned concepts or data.
* Notice the use of transition words and phrases to signal relationships between paragraphs or sections.
* Pay attention to the consistent use of cohesive devices throughout the report to create coherence and facilitate understanding.

### Activity 2 – deconstructing a literature review

The literature review below is taken from the article *Running Away from Cancer: An investigation into the dynamic metabolism of cancer cells under an increase in extracellular lactate concentration* by Sarah Arnold (Menai High School). The complete article is featured in [The Journal of Science Extension Research – Vol. 2, 2023](https://issuu.com/doecurriculum/docs/journal_of_science_extension_research_vol_2_2023/s/21049152).

In this activity, you will use Table 3 to analyse the effect of certain text features, not just identify the purpose. This could include how it positions the reader, how it makes the reader aware of added information, what it shows, or even how text features can help students make connections within and outside of texts.

**Literature Review**

Cancer is the leading cause of death worldwide, responsible for approximately 10 million deaths in 2020 (WHO, 2021). Additionally, it is estimated that ¼ of adults worldwide do not achieve sufficient amounts of physical exercise (Mathewson, 2018). Alarming, emerging studies suggest an intertwine between these global issues, indicating that lactate resulting from single bouts of exercise may have a direct effect on tumour intrinsic factors (Dethlefsen, 2017; Hofmann, 2018).

Cancer cells: An unusual metabolism

Noncancerous cells rely primarily on oxidative phosphorylation (OXPHOS) to generate approximately 70% of their ATP for cellular processes. One fuel for OXPHOS is pyruvate, the end product of the enzymatic breakdown of glucose, known as glycolysis (Ristow, 2006). Under aerobic conditions, pyruvate is transported to the mitochondria where it is oxidised to acetyl-CoA. Acetyl-CoA is further combined with oxaloacetate to initiate the tricarboxylic acid (TCA) cycle, leading to OXPHOS and resulting in the synthesis of ATP energy (Zheng, 2012).

Discovered by Otto Warburg (Warburg et al., 1927), a hallmark of cancerous cells is an accelerated glycolytic metabolism to convert glucose to lactate rather than through OXPHOS, even under fully oxygenated conditions (San-Millán and Brooks 2017). This theory has been supported by various studies (Fadaka et al., 2017; Hirschhaeuser et al., 2011; Jose et al., 2010; Ruiz et al., 2009; San-Millán and Brooks, 2017; Zheng, 2012) and is known as the Warburg Effect or aerobic glycolysis. This phenomenon has remained a mystery across scientific literature, as glycolysis appears inefficient to cancer cells, yielding only 2 ATP molecules, compared to 40 ATP molecules generated by OXPHOS (Fadaka et al., 2017). Consequently, cancerous cells demand a high glucose consumption to maintain homeostasis (Hanahan & Weinberg, 2011).

Whilst previous literature accepts the Warburg Effect is a consequence of defects in cellular respiration, oncogenic alterations, and an overexpression of glycolytic enzymes and metabolite transporters (Hirschhaeuser et al., 2011), the underlying mechanisms of Warburg Effect in cancer cells has been unknown for nearly a century. This may be partially due to an unparalleled focus on genomic techniques in cancer research over the recent decades, which has resulted in a neglected understanding of cancer metabolics (Hofmann, 2018). However, it was recently proposed that the purpose of the Warburg Effect is solely lactate production, known as lactagenesis (San-Millán and Brooks, 2017), implying its role beyond a waste product. During lactagenesis, pyruvate is reduced into lactate, catalysed by the enzyme lactate dehydrogenase (LDH) (Xie et al., 2014), and this reaction is reversible (Mishra and Banerjee, 2019). However, limited studies have accounted for the reversible nature of this equilibrium reaction, in regards to the underlying mechanisms of the Warburg Effect.

Challenging the Warburg paradigm

Building on Warburg’s model, the Reverse Warburg Effect proposes that not all cancer cells undergo aerobic glycolysis, but rather lactate is shuffled and used as an energy source from cancer-associated fibroblasts (CAFS) via monocarboxylate transporters (MCTs) (Wilde et al., 2017). This is supported by the findings that tumours are not exclusively hypoxic, but rather contain aerobic regions which receive shuttled lactate from other glycolytic cancer cells (Semenza, 2008). The Reverse Warburg Effect induces localised lactic acidosis in the tumour microenvironment (TME) causing an accumulation of lactate (Siska, 2020) and due to the high ionisation of lactic acid, a consequent decrease in pH which may favour metastasis, angiogenesis and immunosuppression (de la Cruz- Lopez et al., 2019) and potentially chemoresistance (Brown et al., 2019). However, it is important to note that cancers are extremely heterogeneous with individual metabolic features (Zheng, 2012; Semenza, 2008), potentially limiting the application of Reverse Warburg Effect.

It has also been outlined that the transport of lactate into cancer cells through MCTs is dependent on a concentration gradient (Hofmann 2018; Payen et al., 2019) in order to avoid intracellular acidification (Brown et al., 2019). In 2018, Hofmann further hypothesised if the blood lactate concentration surrounding the tumour can be increased, for example through exercise, this could inhibit the shuttling of lactate and hence the process of the Reverse Warburg Effect. However, it was necessitated by Hofmann that there is extremely limited research on the mechanisms of single bouts of exercise on cancer.

Reverting the Warburg Effect?

The shift of energy metabolism from OXPHOS to aerobic glycolysis has now been widely accepted as a quintessential feature of cancer (Hanahan & Weinberg, 2011). In 2016, Wu inquired if cancer cells can revert from the Warburg effect to OXPHOS when induced by TME pressures. Wu’s results concluded without lactic acidosis, glycolysis and OXPHOS provided 23.7% - 52.2% and 47.8% - 76.3% of total ATP generated, respectively; whilst with lactic acidosis, glycolysis and OXPHOS provided 5.7% - 13.4% and 86.6% - 94.3% of total ATP generated respectively. This suggested lactic acidosis could revert cancer cells from the Warburg to the OXPHOS phenotype. Furthermore, it has been demonstrated, when 4T1 cancer cell lines were induced with lactic acidosis the cells showed a non-glycolytic phenotype characterised by a high oxygen consumption rate over glycolytic rate, negligible lactate production and efficient incorporation of glucose into cellular mass, revealing the dual metabolic nature of cancer cells (Xie et al., 2014).

However, Wu’s study induced the switch between glycolysis and OXPHOS using inhibitors (oligomycin, FCCP, Rotenone/ AntimycinA), and no research appears to stimulate this metabolic switch by increasing extracellular lactate. The study conducted by Wu in 2017 was also the first to quantitatively measure such a metabolic switch and only studied cell lines in two conditions (lactic acidosis and a control group). Therefore, such metabolic switch has not been investigated under varying concentrations of lactate as a means to model the accumulation of lactate as demonstrated in anaerobic exercise. This metabolic switch was also hypothesised by San-Millán and Brooks in 2017, who suggested that aerobic exercise could contribute to counteracting such switch to a glycolytic metabolism in cancer cells by creating epigenetic responses to restorate oxidative phenotypes, however, experimentations have been conducted.

It has been further suggested, if glycolysis could be inhibited in cancer cells, OXPHOS could be restored (Zheng, 2012). This is supported by the increasing number of studies that reveal lactate released by glycolysis and/or CAFS is not discharged as cellular waste, but rather is taken up by oxygenated tumour cells as energy fuel. It has been proposed that this occurs as lactate is converted to pyruvate by LHD where it enters the mitochondria and undergoes OXPHOS (Zheng, 2012). Limited studies however investigate the implications of adding the product, i.e. lactate, to this equilibrium as a potential mechanism for lactic acidosis causing the apparent shift from glycolysis to OXPHOS. However, it was noted that circulating lactate levels are critical in dictating the status of the LHD equilibrium, and Wu in 2014, concluded no net lactate generation was due to the equal rate of pyruvate generated from glycolysis with the removal into the TCA cycle (Xie et al., 2014). However, these concepts are mechanistic explanations of the Warburg Effect, which have yet to be justified by experiment.

A potential model for the effects of exercise on cancer

Despite a history of lactate being defined as only a waste product, over the last decade research has revealed lactate produced by exercise is an active metabolite, moving between cells and capable of being oxidised as a fuel (Philp, et al., 2005). Currently, there is limited research on the intrinsic effects of exercise on cancer cell metabolism. Exercise unquestionably has a role in regulating metabolic processes, but how this consequently affects tumour growth and metastatic rate is not currently mechanistically understood (Hojman, 2018). A study by McTiernan suggested physical activity may be linked to cancer production through exercise-dependent reductions in cancer risk factors; including sex hormones, insulin growth factor (IGF), inflammatory markers and improving immune function. The large inconsistencies regarding the exercise dose which is ideal for cancer management in current research with reference to intensity, duration, frequency and type hinders compelling conclusions (Ashcraft, 2016).

Therefore, cancer cell research demands quantitative over qualitative studies to meet the increasing prevalence of disease. Lactate holds promise to play a role in cellular properties beyond purely a waste product (San-Millan, 2017). Therefore, investigations in the role of lactate on cancer cells in vitro, could provide insight into a further understanding of the potential benefits, or risks, of exercising for cancer patients.

Table 3 – analysing the effect of text features

|  |  |  |
| --- | --- | --- |
| Text feature | Explain its purpose | Analyse the effect of using this feature |
| Quoting statistics, for example, ‘10 million deaths’ | Used to… | This shows… |
| Use of citations including WHO and Matthewson |  |  |
| Subheadings |  |  |
| The rhetorical question ‘Reverting the Warburg Effect?’ |  |  |
| Scientific terminology and definitions. For example, ‘pyruvate: The end product of the enzymatic breakdown of glucose, known as glycolysis.’ |  |  |
| Cohesive devices, including linking words and transitions. For example, phrases like ‘building on Warburg’s model’ and ‘however, it is important to note.’ |  |  |
| Introductory paragraph |  |  |
| Concluding paragraph |  |  |

### Activity 3 – guiding questions for reading scientific reports

|  |  |
| --- | --- |
| Guiding questions | Notes |
| **Abstract:**   * What is the main objective of the research, and what were the key findings? * What is the significance of the research, and how does it contribute to the field? * How does the abstract provide a concise summary of the entire report? |  |
| **Literature Review:**   * What is the issue the research is addressing? * What is already known about the issue in the literature? * What are the gaps in the literature? * What does the research hope to achieve? * How does the author build a rationale for their research question? |  |
| **Scientific Research Question:**   * What is the research question or hypothesis being investigated? * How is the research question framed, and why is it significant? * How does the research question relate to the broader field of study? |  |
| **Methodology:**   * What is the research design, and how is it appropriate for the research question? * What data collection methods were used, and how were they applied? * What measures were taken to ensure the validity and reliability of the study? |  |
| **Results:**   * What were the main findings of the study? * How were the results analysed and presented? * What are the implications of the results for the research question and the broader field of study? |  |
| **Discussion:**   * How do the results relate to the research question and the literature reviewed? * What are the study's limitations, and how might they affect the interpretation of the results? * How do the results contribute to the broader field of study, and what are the implications for future research? |  |
| **Conclusion:**   * What were the main contributions of the study? * How do the findings relate to the research question and the literature reviewed? * What are the study's broader implications, and what are the next steps for research in this area? |  |

## Support and alignment

**Resource evaluation and support**: all curriculum resources are prepared through a rigorous process. Resources are periodically reviewed as part of our ongoing evaluation plan to ensure currency, relevance and effectiveness. For additional support or advice, or to provide feedback, contact the Science Curriculum team by emailing [Science7-12@det.nsw.edu.au](mailto:Science7-12@det.nsw.edu.au).

**Differentiation:** further advice to support Aboriginal and Torres Strait Islander students, EALD students, students with a disability and/or additional needs and High Potential and gifted students can be found on the [Planning, programming and assessing 7-12](https://education.nsw.gov.au/teaching-and-learning/curriculum/planning-programming-and-assessing-k-12/planning-programming-and-assessing-7-12) webpage.

**Assessment**: further advice to support formative assessment is available on the [Planning, programming and assessing 7-12](https://education.nsw.gov.au/teaching-and-learning/curriculum/planning-programming-and-assessing-k-12/planning-programming-and-assessing-7-12) webpage.

**Professional learning**: relevant professional learning is available on the [Science statewide staffroom](https://education.nsw.gov.au/teaching-and-learning/curriculum/statewide-staffrooms), and [HSC Professional Learning](https://education.nsw.gov.au/teaching-and-learning/professional-learning/hsc-pl). [Stage 6 Literacy in context](https://education.nsw.gov.au/teaching-and-learning/curriculum/literacy-and-numeracy/teaching-and-learning-resources/literacy/stage-6-literacy-in-context-writing/science) provides further advice to teachers to improve student writing.

**Related resources**: further resources to support Stage 6 Investigating Science can be found on the [HSC hub](https://www.hschub.nsw.edu.au/) and the [Science K-12](https://education.nsw.gov.au/teaching-and-learning/curriculum/science) page.

**Consulted with**: Multicultural Education and subject matter experts.

**Alignment to system priorities and/or needs**: [School Excellence Policy](https://education.nsw.gov.au/policy-library/policies/pd-2016-0468), [School Success Model](https://education.nsw.gov.au/public-schools/school-success-model/school-success-model-explained).

**Alignment to the School Excellence Framework**: this resource supports the [School Excellence Framework](https://education.nsw.gov.au/policy-library/policies/pd-2016-0468) elements of curriculum (curriculum provision) and effective classroom practice (lesson planning, explicit teaching).

**Alignment to Australian Professional Teaching Standards**: this resource supports teachers to address [Australian Professional Teaching Standards](https://educationstandards.nsw.edu.au/wps/portal/nesa/teacher-accreditation/meeting-requirements/the-standards/proficient-teacher) 1.5.2, 2.5.2, 3.2.2, 3.3.2.

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## References

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### Further reading

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