

# BT 623: Research Methodology

## Lecture 19



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# Science and serendipity: famous accidental discoveries

Most scientific breakthroughs take years of research – but often, serendipity provides the final push, as these historic discoveries show .

– by Samira Shackle –

THURSDAY, 2ND APRIL 2015

*This piece accompanies Marcus Chown's feature on the discovery of cosmic background radiation, from the Spring 2015 edition of New Humanist.*

## Penicillin

Perhaps the most famous accidental discovery of all is penicillin, a group of antibiotics used to combat bacterial infections. In 1928, Scottish biologist Alexander Fleming took a break from his lab work investigating staphylococci and went on holiday. When he returned, he found that one Petri dish had been left open, and a blue-green mould had formed. This fungus had killed off all surrounding bacteria in the culture. The mould contained a powerful antibiotic, penicillin, that could kill harmful bacteria without having a toxic effect on the human body.

At the time, Fleming's findings didn't garner much scientific attention. In fact, it took another decade before this drug was available for use in humans. Retrospectively, Fleming's chance

Read the article and also collect similar papers/articles.

**Assignment:** Select any Case of Serendipity and Prepare a Poster (ppt landscape)

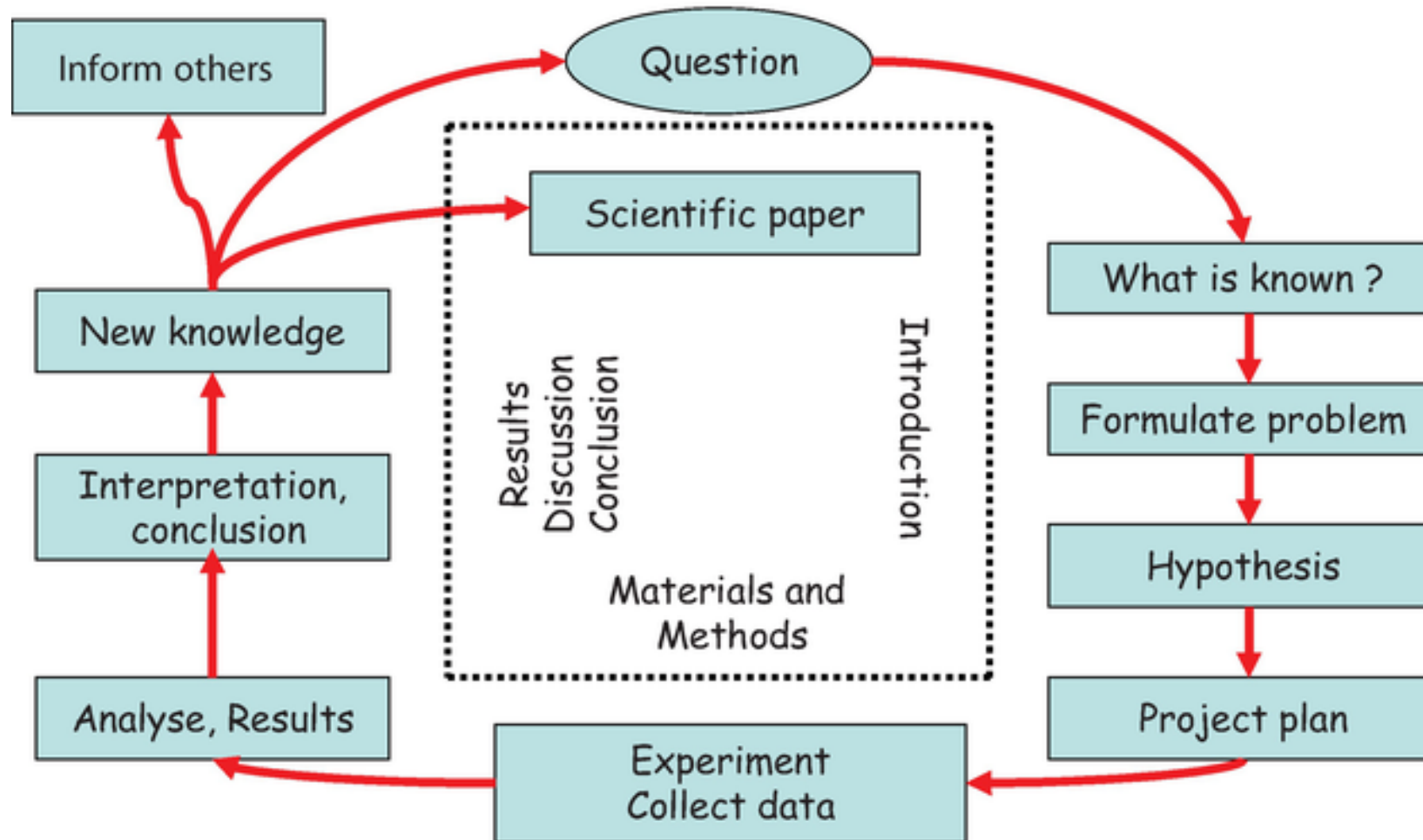
Members per team: 2

Deadline Two weeks from today:  
27.09.2024

<https://newhumanist.org.uk/articles/4852/science-and-serendipity-famous-accidental-discoveries>

# **Scientific Writing in Biological Sciences**

# The research and writing process



**Fig.** Link of the research process with the writing structure (after Malmfors et al., 2002).

# CONTENT

- ☐ **Understanding the Fundamentals of Scientific Writing**
- ☐ **Research Methodology and Data Presentation**
- ☐ **Writing and Revising Scientific Manuscripts**
- ☐ **Ethical Considerations in Scientific Writing**

## **SECTION 1**

# **Understanding the Fundamentals of Scientific Writing**

# INTRODUCTION

- Scientific writing is a specialized form of communication, primarily intended to convey complex research, experiments, or theories in a clear, precise, and accessible way to other scientists and professionals.
- It requires a methodical approach and adherence to certain standards and conventions.
- (Turbek et al., 2016) provides a detailed, structured guide for undergraduate students in the biological sciences to help them effectively write scientific papers and reports. The authors presents the basic structure to be followed in scientific writing as:
  - **Introduction:** provides background information, presents a specific research question or knowledge gap, and introduces the hypothesis.
  - **Materials and Methods:** This section describes the experimental procedure, including the equipment, materials, and statistical analyses used.
  - **Results:** Objective presentation of key findings, supported by graphs and tables, without interpretation.
  - **Discussion and Conclusion:** Interpretation of the results, linking them back to the research question, explaining their significance, and discussing the broader implications of the study.

**(Turbek et al., 2016) explains:**

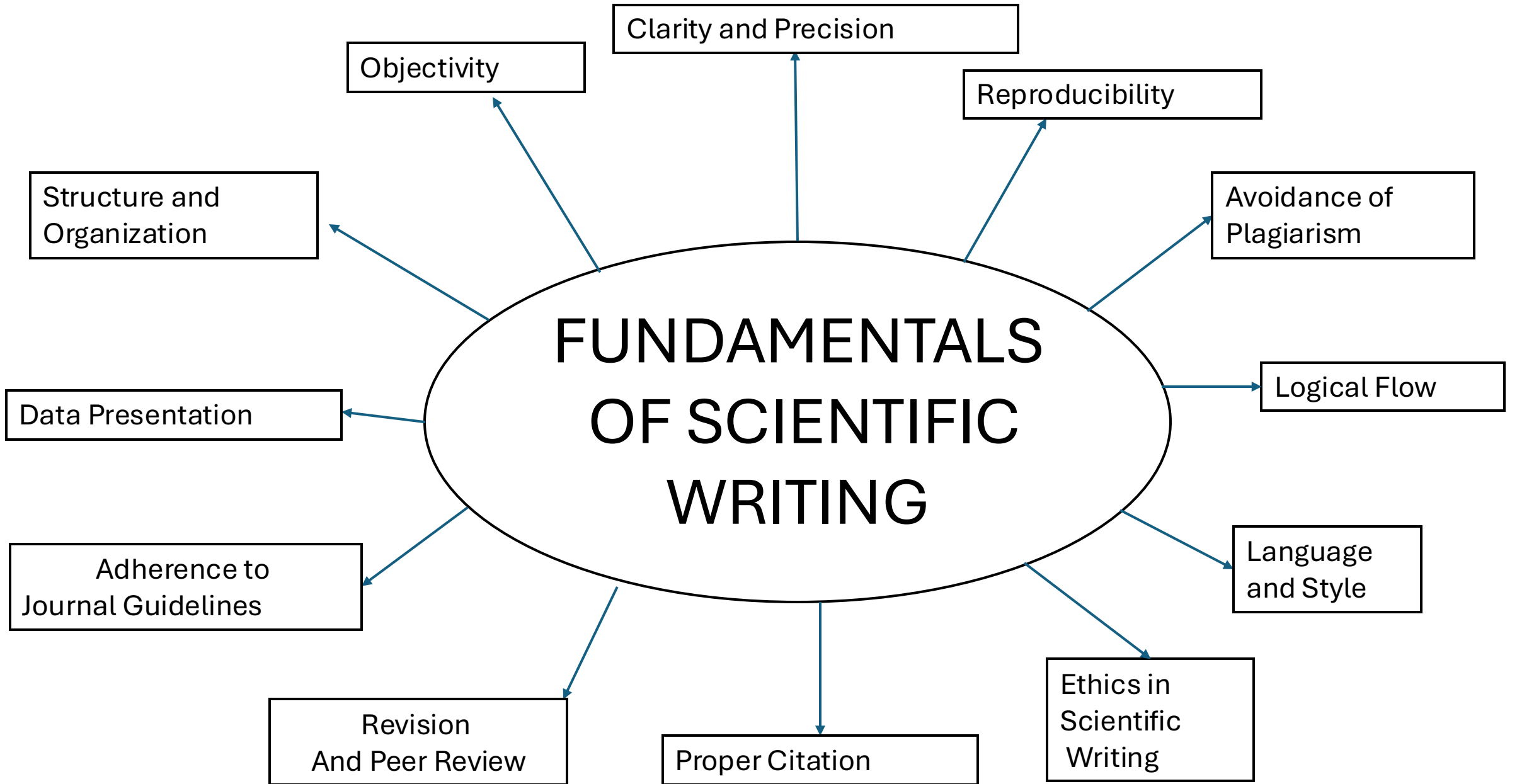
- **Writing Techniques and Tips:**

- The author emphasizes the importance of understanding your audience, organizing your writing to tell a coherent story, and using clear, concise language.
- The use of the active voice is recommended to strengthen writing, with occasional passive voice when it improves clarity.
- Flow, structure, and word choice are critical for connecting ideas and making the paper engaging for the reader.

- **Editing and Peer Review:**

- Re-reading and editing the paper is essential, and feedback from peers or classmates can greatly enhance the quality of the writing.
- The editing process should involve checking for gaps in the narrative, improving sentence structure, and ensuring clarity.





# Importance of Scientific Writing in Biology

## Clarity in Communication

Scientific writing ensures that complex biological concepts are conveyed clearly and accurately, facilitating understanding among researchers, practitioners, and the public.

## Advancement of Knowledge

Well-documented research findings contribute to the body of scientific knowledge, enabling further studies and innovations in the field of biology.

## Professional Credibility

Mastery of scientific writing enhances a biologist's professional reputation, as published works are often viewed as a benchmark for expertise and reliability in the scientific community.

# **Key Components of Scientific Papers**

## **Abstract and Introduction**

The abstract provides a concise summary of the research, while the introduction outlines the background, significance, and objectives of the study, setting the stage for the reader.

## **Methods and Materials**

This section details the experimental design, procedures, and materials used, allowing for reproducibility and transparency in research methodology.

## **Results and Discussion**

The results present the findings with appropriate data representation, followed by a discussion that interprets the results, explores implications, and suggests future research directions.

# Common Formats and Structures

## IMRaD Structure

This is the most common format in scientific writing

IMRaD stands for Introduction, Methods, Results, and Discussion.

**Introduction:** This section outlines the background, purpose, and significance of the research.

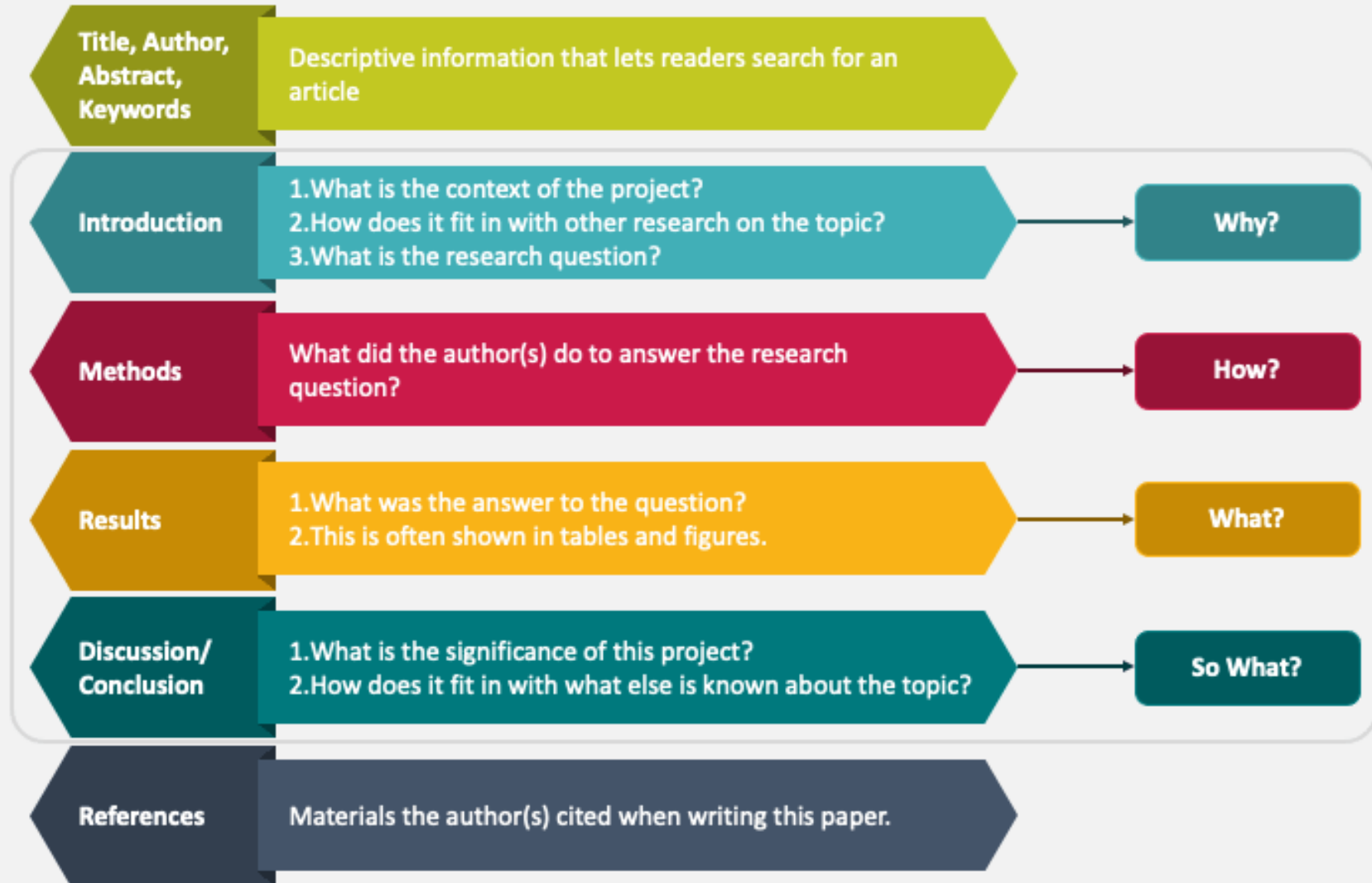
It includes a review of existing literature and clearly states the research question or hypothesis.

**Methods (or Materials and Methods):** Includes detailed description of how the research was conducted, including the experimental design, materials, and procedures. This allows for reproducibility.

**Results:** Presents the findings of the research without interpretation. Data is often presented in tables, graphs, or charts.

**Discussion:** Interprets the results, comparing them with previous research, and discussing their implications. It should also consider any limitations or anomalies in the findings.

# IMRAD METHOD



## **Snippets of Writing an Effective Discussion:**

**1.Summarize Key Findings:** The study recommends actions to reduce plastic pollution: (1) refuse unnecessary plastics (e.g., straws), (2) reduce single-use plastics by refilling or buying larger items, (3) replace plastics with reusable or eco-friendly alternatives, and (4) dispose of non-reusable items like wet wipes properly.

**2.Acknowledge Hypothesis Limitations:** All neck postures of live giraffes can be replicated using a virtual skeleton, refuting the hypothesis that certain postures require disarticulating vertebrae.

**3.Contextualize within Previous Research:** Consistent with other studies, our results suggest that body mass may be more useful than condition indices for linking nutritional changes to polar bear population dynamics.

**4.Discuss Future Research:** Our findings pave the way for further investigation into laryngeal variation across mammalian clades, potentially enhancing our understanding of primate vocal evolution.

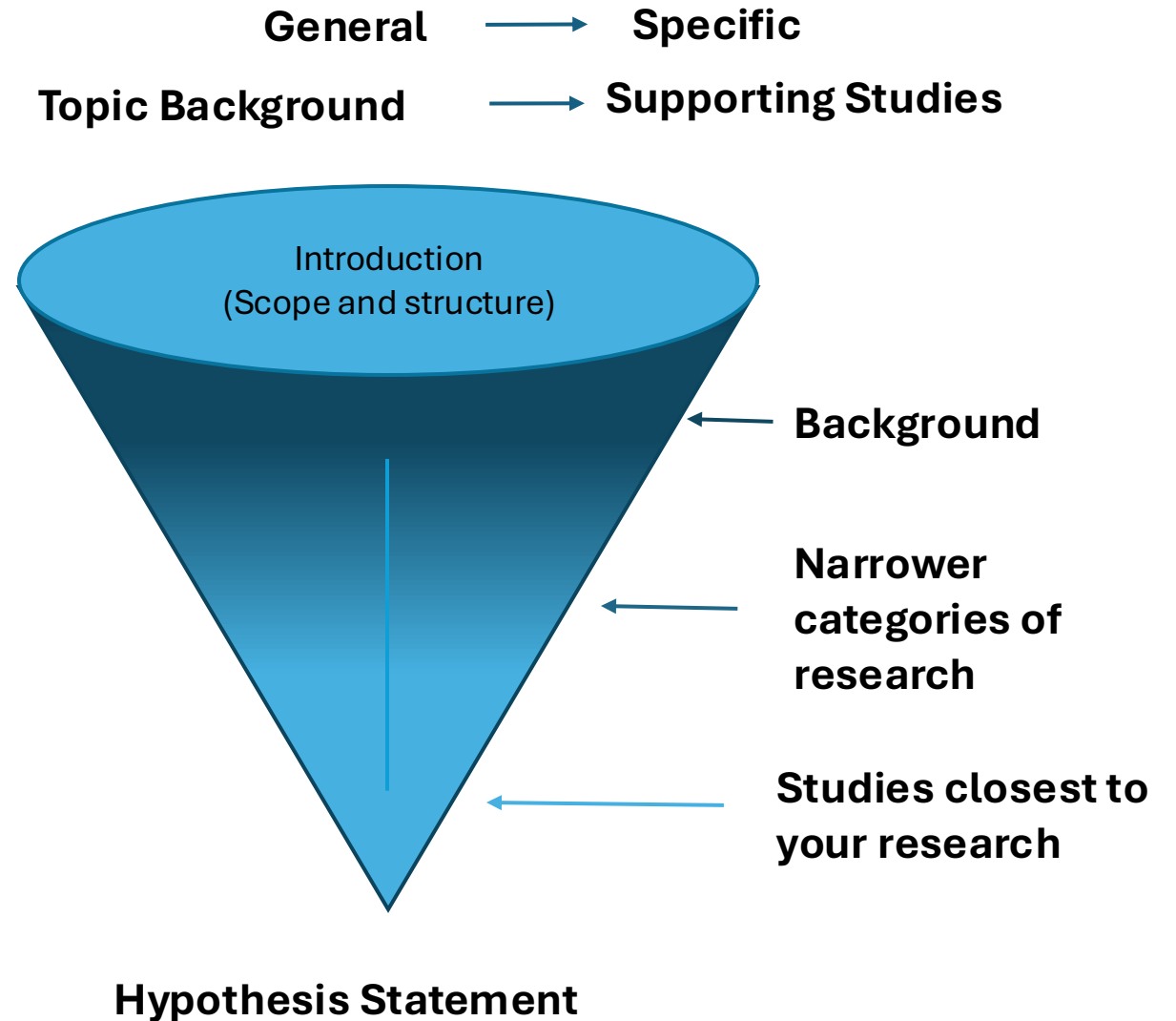
**5.Provide a Take-Away Statement:** This reinforces the idea that tyrannosaurids were not only apex predators in Cretaceous ecosystems but also among the most skilled hunters, combining efficient anatomy with formidable power.

# Common Formats and Structures

## Literature Review Format

This format synthesizes existing research on a specific topic, highlighting gaps in knowledge and establishing the context for new research, often used in thesis and dissertation writing.

## Structure of Literature Review



## Common Formats and Structures

### Case Study Format

In biological sciences, case studies focus on detailed examinations of specific instances or phenomena, allowing for in-depth analysis and insights that contribute to broader scientific understanding.

Key points to be considered while writing case studies:

**Integration:** Make sure the case study is well integrated into the article and contributes to the overall research objectives.

**Balance Specificity and Generalization:** Provide enough detail to be informative but also relate the case study to broader issues and theory.

**Use Clear Subheadings:** Subheadings for each section (e.g., “Case Background,” “Findings,” “Analysis”) help guide the reader through your argument.

**Follow Journal Guidelines:** Each journal or publication may have specific requirements for presenting case studies. Make sure to follow these closely.

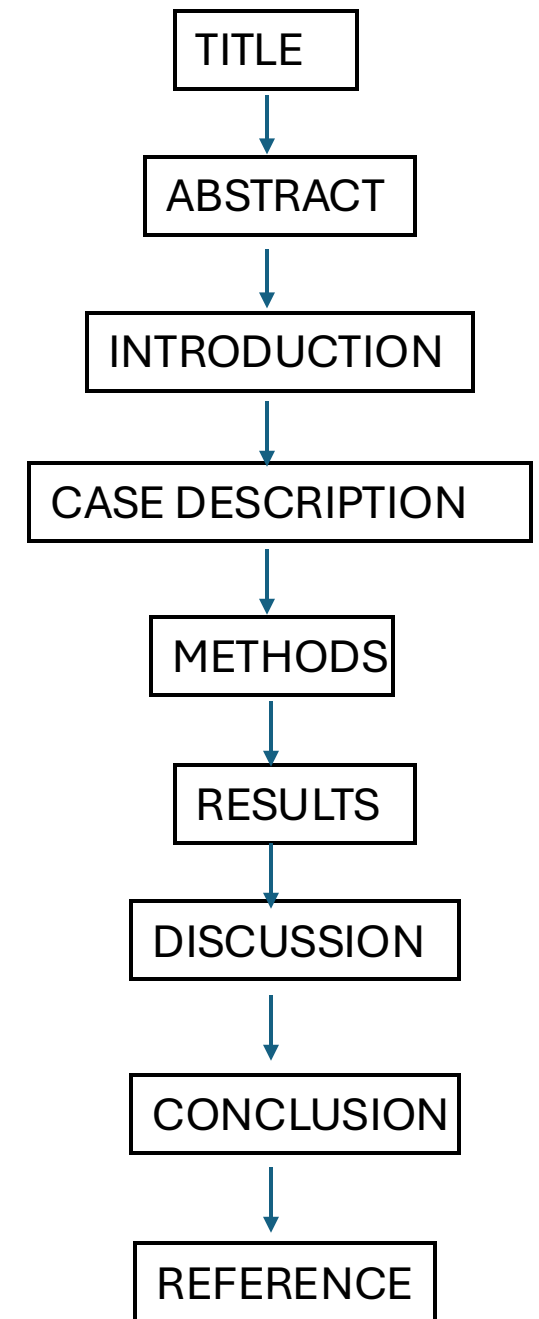


Fig. Structure for case studies



# **Audience and Purpose in Scientific Communication**

## **Understanding Audience Needs**

Recognizing the diverse backgrounds and expertise levels of the audience is crucial for tailoring scientific communication, ensuring that complex biological concepts are accessible and engaging to both specialists and non-specialists.

## **Defining Communication Objectives**

Clearly articulating the purpose of the communication—whether to inform, persuade, or educate—guides the structure and tone of the writing, enhancing its effectiveness in conveying key messages in biological sciences.

## **Adapting Language and Style**

Employing appropriate terminology and stylistic choices based on the audience's familiarity with the subject matter fosters better comprehension and retention of information, ultimately improving the impact of scientific communication.

## **Section 2**

# **Research Methodology and Data Presentation**

# **Designing a Research Study**

## **Defining Research Objectives**

Clearly articulate the primary goals of the study, ensuring they are specific, measurable, achievable, relevant, and time-bound (SMART) to guide the research process effectively.

## **Selecting Appropriate Methodologies**

Choose suitable research designs (e.g., experimental, observational, or qualitative) and methodologies that align with the research questions and objectives, considering factors such as sample size and data collection techniques.

## **Ethical Considerations**

Address ethical issues related to the study, including informed consent, confidentiality, and the welfare of any living subjects involved, ensuring compliance with institutional and regulatory guidelines.

# Collecting and Analyzing Data

## **Data Collection Techniques**

Employ a variety of data collection methods such as surveys, experiments, and observational studies to gather comprehensive and reliable data relevant to the research question.

## **Statistical Analysis Methods**

Utilize appropriate statistical tools and software to analyze collected data, ensuring that the chosen methods align with the research design and hypotheses for valid results interpretation.

## **Highlighting Key Trends**

Emphasize important trends and patterns in the data through concise summaries, allowing readers to grasp critical insights quickly while encouraging further exploration of the results presented.

# Presenting Results Effectively

## **Clear Data Presentation**

Utilize tables and figures to present data clearly, ensuring that each visual aid is labeled appropriately and includes legends to enhance understanding and facilitate quick interpretation of results.

## **Contextualizing Findings**

Discuss the results in relation to the research questions and hypotheses, providing context that helps readers understand the significance of the findings within the broader scope of biological sciences.

## **Highlighting Key Trends**

Emphasize important trends and patterns in the data through concise summaries, allowing readers to grasp critical insights quickly while encouraging further exploration of the results presented.

# **Visual Aids: Graphs, Tables, and Figures**

## **Importance of Visual Aids**

Visual aids enhance comprehension by presenting complex data in a simplified format, making it easier for readers to grasp key findings and trends in biological research.

## **Types of Visual Aids**

Common types include graphs (for trends and relationships), tables (for detailed data comparison), and figures (for illustrations or diagrams), each serving distinct purposes in data presentation.

## **Best Practices for Design**

Effective visual aids should be clear, well-labeled, and appropriately scaled, ensuring that they convey information accurately while maintaining aesthetic appeal to engage the audience.

## **Section 3**

# **Writing and Revising Scientific Manuscripts**

# Drafting the Manuscript: Tips and Techniques

## **Establish a Clear Outline**

Begin by creating a detailed outline that organizes your thoughts and research findings into logical sections, ensuring a coherent flow of information throughout the manuscript.

## **Focus on Conciseness and Clarity**

Use precise language and avoid unnecessary jargon to enhance readability; aim for clear, concise sentences that effectively communicate complex biological concepts to your audience.

## **Incorporate Feedback Early**

Seek input from colleagues or mentors during the drafting process to identify areas for improvement, allowing for revisions that strengthen the manuscript before finalizing it for submission.



# **The Importance of Peer Review**

## **Quality Assurance in Research**

Peer review serves as a critical quality control mechanism, ensuring that scientific manuscripts meet rigorous standards of accuracy, validity, and reliability before publication, thereby enhancing the credibility of the research.

## **Constructive Feedback for Improvement**

The peer review process provides authors with valuable feedback from experts in the field, allowing them to refine their arguments, clarify methodologies, and address potential weaknesses in their studies, ultimately leading to stronger publications.

## **Facilitating Scientific Dialogue**

Peer review fosters a collaborative environment within the scientific community by encouraging discourse among researchers, promoting the exchange of ideas, and helping to identify emerging trends and gaps in knowledge that can guide future research efforts.

# Common Pitfalls and How to Avoid Them

## Lack of Clarity

Ambiguous language and convoluted sentences can obscure the main message; to avoid this, prioritize clear and straightforward writing, using simple terms and well-structured sentences to enhance reader comprehension.

## Inadequate Literature Review

Failing to thoroughly review existing literature can lead to redundancy or misinterpretation of findings; ensure a comprehensive literature review is conducted to contextualize your research within the current scientific landscape.

## Neglecting Formatting Guidelines

Ignoring specific formatting requirements from journals can result in rejection; familiarize yourself with the target journal's submission guidelines early in the writing process to ensure compliance and professionalism.

## **Finalizing Your Manuscript for Submission**

### **Thorough Proofreading**

Conduct a meticulous proofreading of the manuscript to identify and correct grammatical errors, typos, and inconsistencies, ensuring that the final document is polished and professional before submission.

### **Adherence to Journal Guidelines**

Review and comply with the specific formatting and submission requirements of the target journal, including citation styles, word limits, and supplementary materials, to enhance the likelihood of acceptance.

### **Final Review by Peers**

Seek a final review from colleagues or mentors who can provide fresh perspectives on the manuscript, helping to identify any overlooked issues and ensuring that the content is clear, coherent, and impactful.

## **Section 3**

# **Ethical Considerations in Scientific Writing**

# Plagiarism and Academic Integrity

## Definition of Plagiarism

Plagiarism involves using someone else's work, ideas, or expressions without proper attribution, which undermines the integrity of scientific research and can lead to severe academic consequences.

**Credit to Original Authors:** Any data, ideas, or findings from other researchers must be properly cited and referenced. Failing to give credit constitutes plagiarism, which is an ethical breach.

**Self-Plagiarism:** Researchers should not recycle their own previously published work without proper attribution or disclosure, even if the work is their own.

**Contribution Acknowledgment:** All collaborators, co-authors, and contributors should be properly acknowledged. Ghostwriting or excluding deserving contributors violates ethical principles.

# What is Plagiarism and How to Avoid It?

1 Plagiarism is using others' work without credit

2 Forms of plagiarism include copying and paraphrasing without attribution

3 It is unethical and frowned upon in various fields

4 To avoid plagiarism, cite and reference sources properly

5 Know the required citation style and follow it closely

10 Be honest and seek permission when in doubt

9 Use plagiarism detection tools to check for unintentional plagiarism

8 Plagiarism applies to creative works like images and music

7 When paraphrasing, use your own words and cite the source

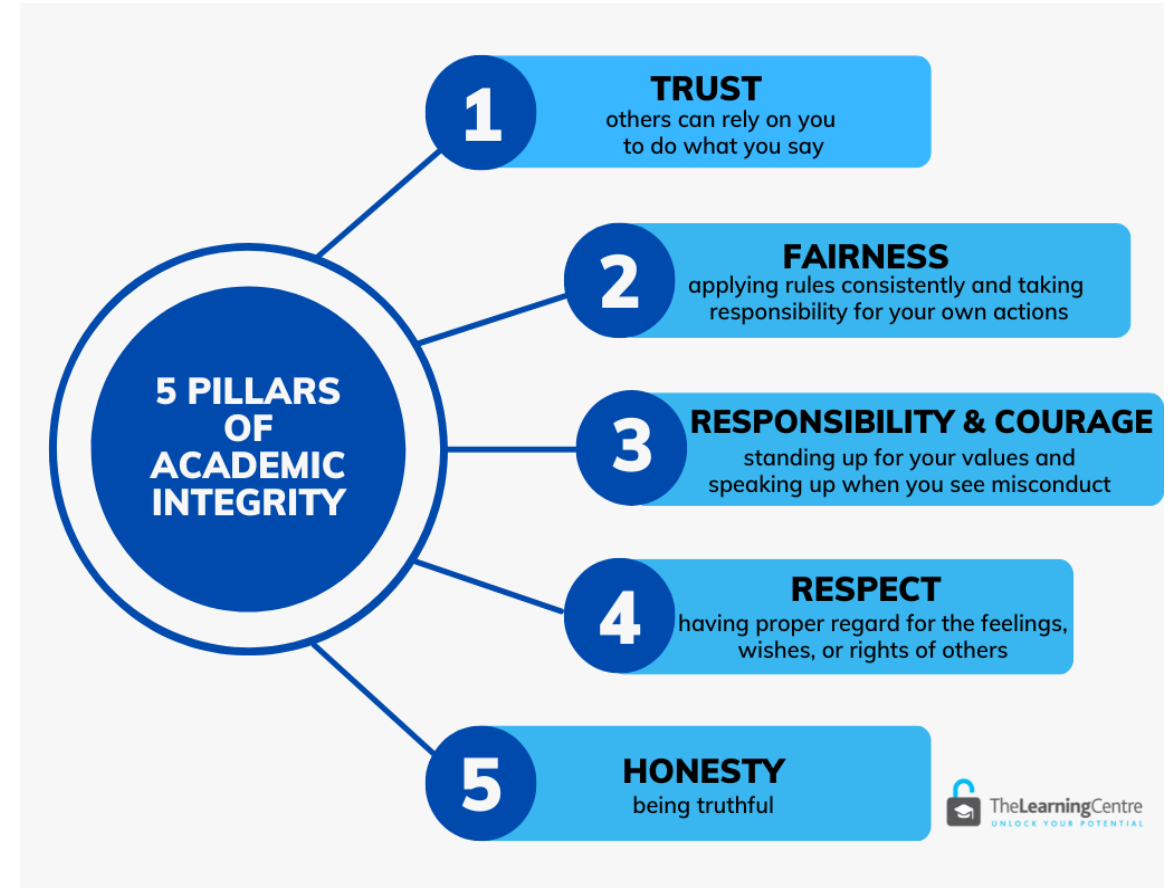
6 Take thorough notes with source details while researching

# Plagiarism and Academic Integrity

## ❑ Importance of Academic Integrity

Upholding academic integrity fosters trust in the scientific community, ensuring that research findings are credible and that authors receive appropriate recognition for their contributions, which is essential for the advancement of knowledge.

- **Trust in the Academic Community:** Academic integrity fosters trust between students, educators, and institutions.
- **Credibility of Research:** Research built on academic integrity is credible, reliable, and valuable.



Source: <https://www.jcu.edu.au/b/current-students/learningcentre/during-the-study-period/academic-integrity>

## Plagiarism and Academic Integrity

Engaging in plagiarism can result in loss of reputation, retraction of published work, and legal repercussions, highlighting the necessity for researchers to adhere to ethical standards in their writing practices.

❑ **Disciplinary Actions:** In educational settings, plagiarism is often considered a serious violation of academic integrity.

Students found guilty of plagiarism may face:

- Failing grades on assignments or courses.
- Suspension or expulsion from the institution.
- Loss of academic honors, scholarships, or financial aid.

❑ **Copyright Infringement:** Plagiarism can violate copyright laws, especially if copyrighted material is used without permission or attribution.

This can lead to:

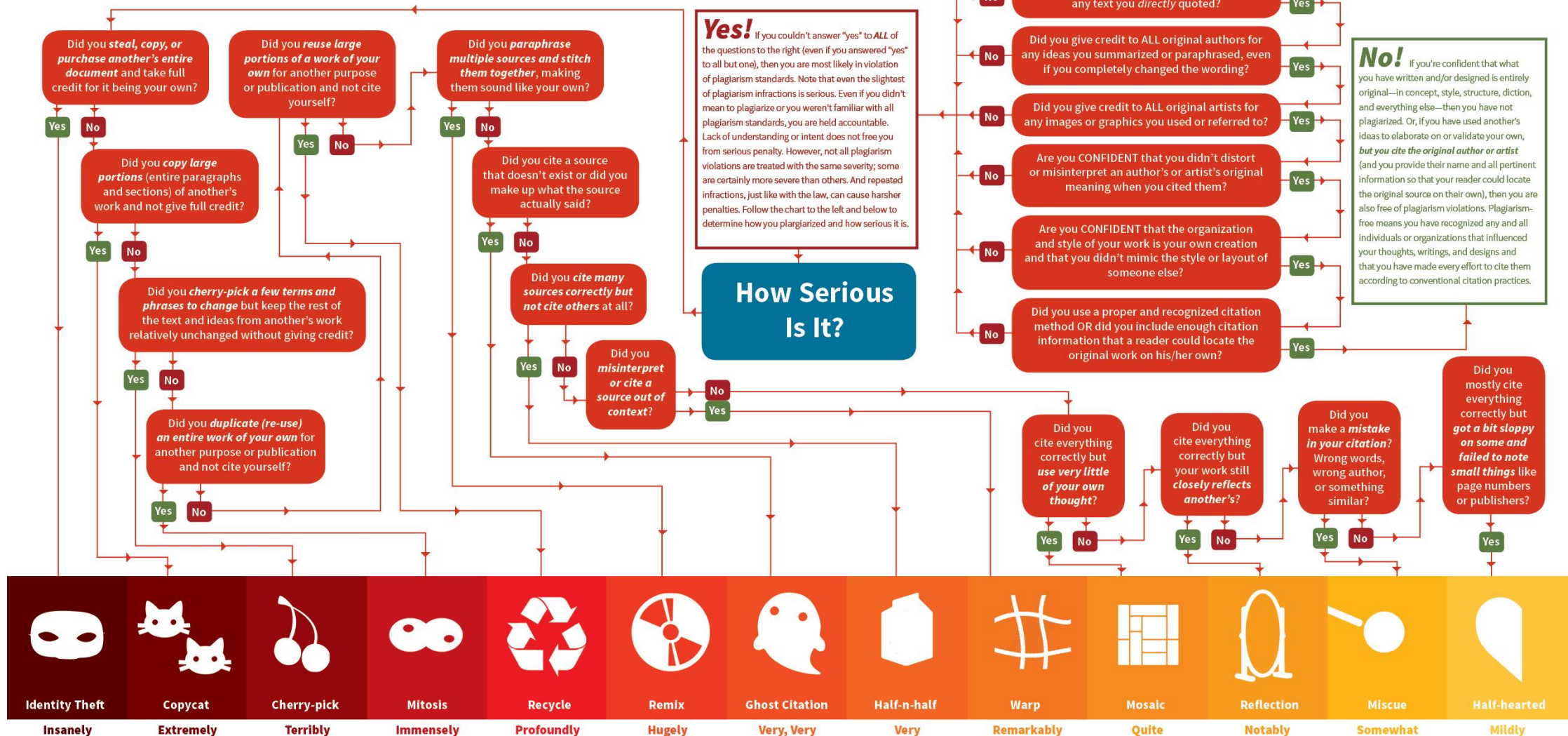
- Legal action by the original author or copyright holder.
- Fines and monetary penalties.
- Lawsuits and damage claims for unauthorized use of intellectual property.

❑ **Litigation Costs:** The legal process involved in defending a plagiarism accusation or paying for settlements can be expensive and time-consuming.



# Did I Plagiarize?

## The Types and Severity of Plagiarism Violations



### Plagiarism Severity Meter: How Serious Is the Violation?

## Consequences of Plagiarism

### 8 Research and publication impact:

Plagiarism leads to paper retractions, loss of funding, and research collaboration difficulties

### 1 Academic penalties:

Plagiarism leads to failing grades, suspension, or expulsion

### 7 Impaired learning and growth:

Plagiarism hampers skill development and academic progress

### 2 Reputation damage:

Plagiarism undermines trust and credibility

### 6 Ethical implications:

Plagiarism violates integrity and has long-lasting personal and professional consequences

### 3 Legal issues:

Plagiarism can result in lawsuits, fines, and legal consequences

### 5 Lost opportunities:

Plagiarism can cost scholarships, research positions, and admission to prestigious programs

### 4 Professional setbacks:

Plagiarism hinders career advancement and damages professional relationships

# **Authorship and Contribution Guidelines**

## **Criteria for Authorship**

Authorship should be based on substantial contributions to the conception, design, execution, or interpretation of the research; all authors must have participated sufficiently to take public responsibility for the content.

## **Acknowledgment of Contributions**

Individuals who contributed to the research but do not meet authorship criteria should be acknowledged in the manuscript; this includes technical support, data collection, and administrative assistance.

## **Transparency in Author Roles**

Clearly define each author's role in the research process to promote transparency and accountability; this can help prevent disputes regarding contributions and ensure proper credit is given.

# Ethical Reporting of Research Findings

## Accuracy in Data Reporting

Researchers must ensure that all data presented in their findings is accurate and truthful, avoiding any manipulation or selective reporting that could mislead the scientific community and the public.

**No Data Manipulation:** Data manipulation—such as cherry-picking data points, removing outliers without justification, or falsifying results—is a serious ethical violation.

**No Selective Reporting:** All relevant results, including negative or null findings, should be reported. Selectively reporting only positive results distorts the scientific record and leads to biased interpretations.

**Appropriate Use of Statistics:** Statistical tests should be chosen and applied appropriately. Researchers should avoid "p-hacking" (manipulating data or analysis until statistically significant results are obtained), and they should clearly explain any adjustments made to the data.



# Ethical Reporting of Research Findings

## ❑ Disclosure of Conflicts of Interest

It is essential to disclose any potential conflicts of interest that may influence the research outcomes, as transparency fosters trust and integrity in scientific communication and helps mitigate bias.

- **Conflicts of Interest (COI):**

- Researchers must disclose any financial, personal, or professional relationships that could influence their interpretation of the data or the publication of the findings.
- This includes funding sources or affiliations that might create a bias.

- **Transparency in Sponsorship:**

- If the research was funded by a third party, especially if the funder has a vested interest in the results, this should be disclosed.
- Funding sources should not influence the objectivity of the findings.

# Ethical Reporting of Research Findings

## Respect for Participant Privacy

When reporting research findings involving human or animal subjects, researchers must prioritize the confidentiality and privacy of participants, adhering to ethical guidelines that protect their identities and personal information.

**Anonymity of Participants:** Personally identifiable information should be excluded unless explicit consent has been obtained.

**Informed Consent:** Participants should have been made aware of how the data would be used and reported.

**Data Confidentiality:** Sensitive data should be handled with care and must be stored securely and shared only with those authorized.



# Ethical Reporting of Research Findings

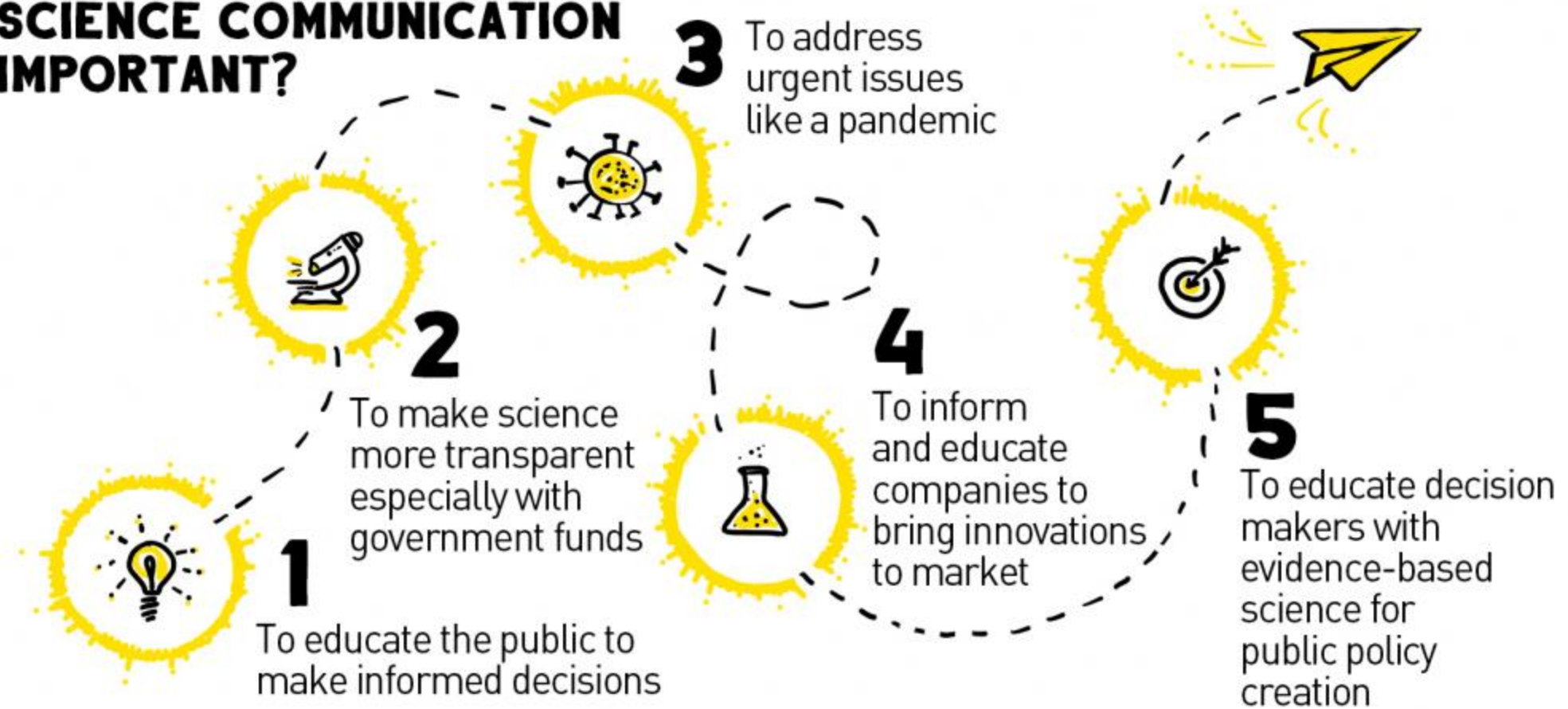
## ❑ Handling and Reporting of Errors

**Correction of Errors:** If errors are discovered post-publication, researchers are ethically obliged to issue corrections, retractions, or errata, depending on the severity of the issue.

**Timely Reporting:** Errors should be reported and corrected as soon as they are identified, regardless of whether they were intentional or accidental.

**Retractions:** In cases where findings are proven to be fraudulent, flawed, or unreliable, researchers must work with journals or institutions to retract the work and inform the academic community.

# WHY IS GOOD SCIENCE COMMUNICATION IMPORTANT?





# Scientific versus popular science writing

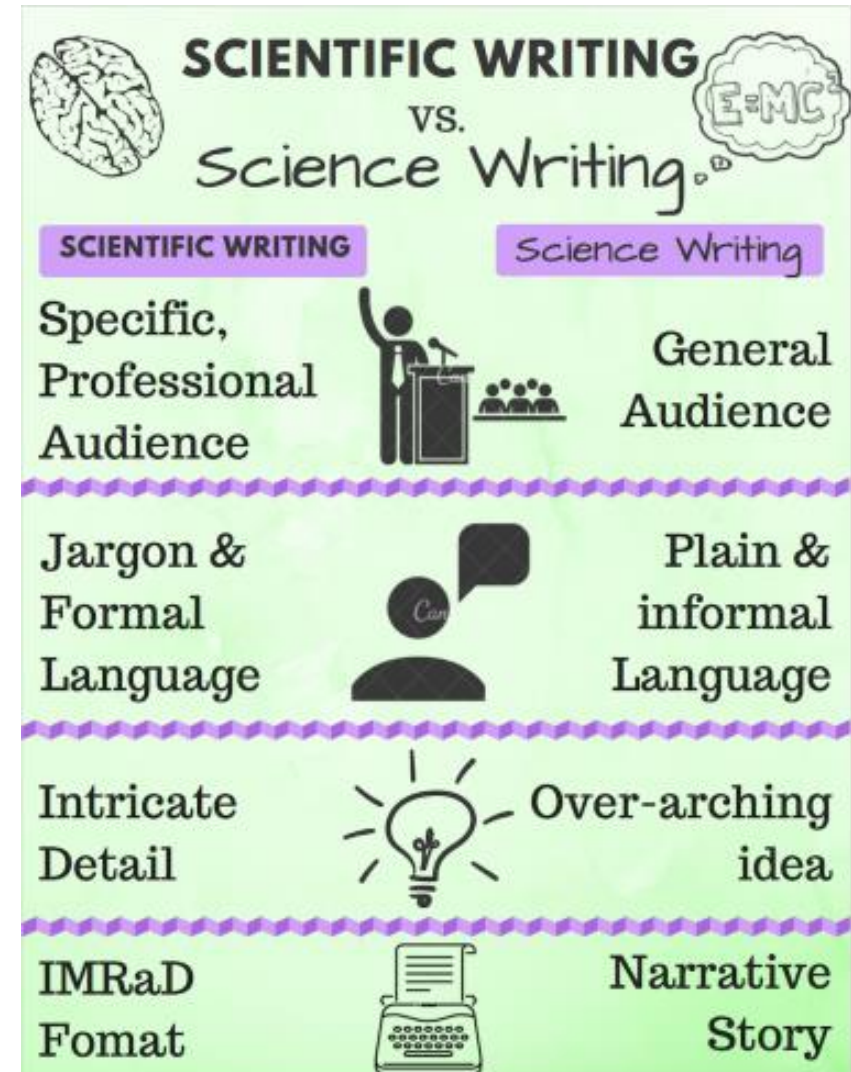
## Scientific document

## Popular science article

Different target group  
Different organization  
Different language, layout

- New knowledge
- Enables others to repeat
- Logical and clear IMRAD
- Technical terms
- Tables, figures
- References

- Knowledge review
- Arouse interest
- Teach: Influence the reader
- Illustrations as tool to read and understand
- Examples



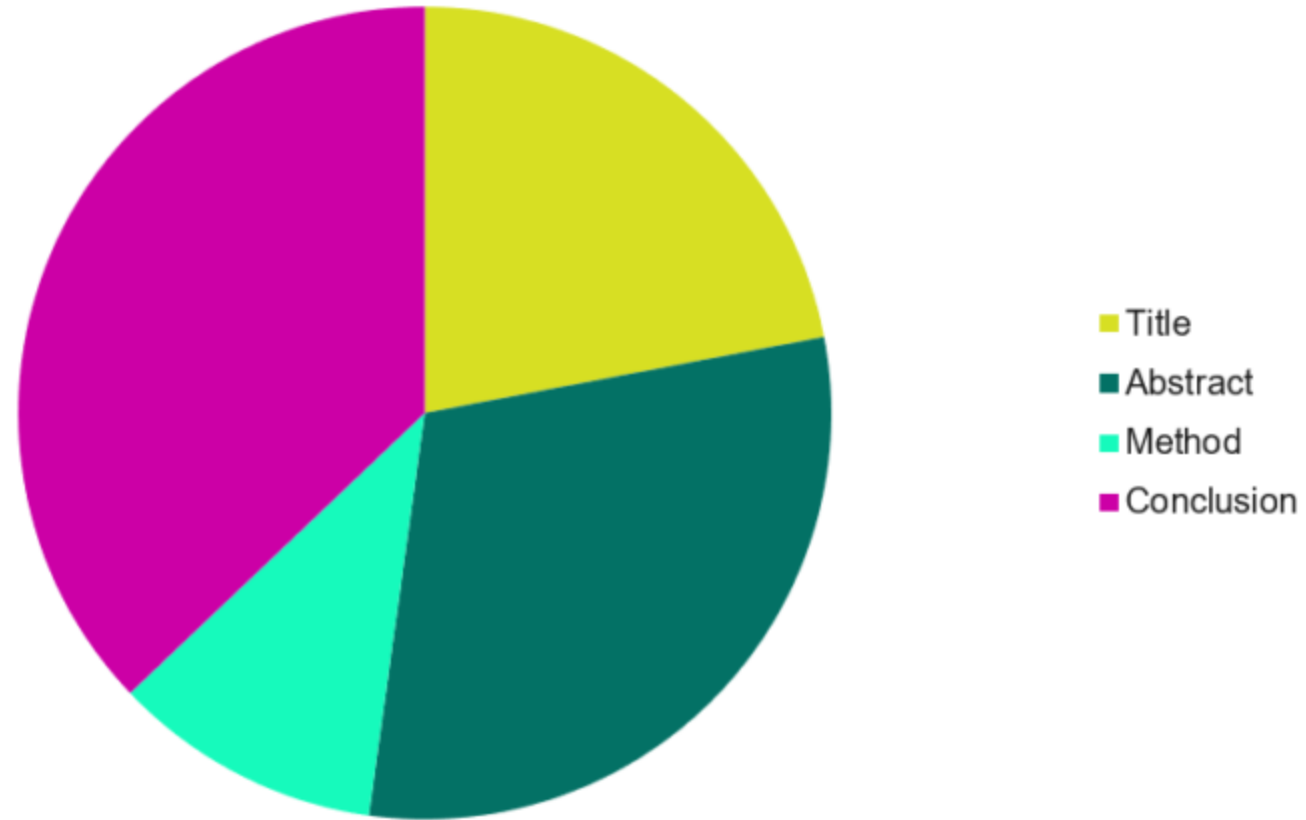
# References

- Turbek, S. P., Chock, T. M., Donahue, K., Havrilla, C. A., Oliverio, A. M., Polutchko, S. K., Shoemaker, L. G., & Vimercati, L. (2016). Scientific Writing Made Easy: A Step-by-Step guide to undergraduate writing in the biological sciences. Bulletin of the Ecological Society of America, 97(4), 417–426. <https://doi.org/10.1002/bes2.1258>
- <https://www.tutorsindia.com/blog/academic-integrity-importance/>
- <https://researcheracademy.elsevier.com/interactive-course/display/825/393>
- [https://commons.wikimedia.org/wiki/File:Wineglass\\_model for IMRaD structure..png](https://commons.wikimedia.org/wiki/File:Wineglass_model_for_IMRaD_structure..png)
- <https://blog.wordvice.com/how-to-write-a-literature-review/>

**Thank You**

**Art of writing**

Which part of a manuscript do you find most challenging to write?



<https://plos.org/resource/how-to-write-conclusions/>

## How to structure a discussion

Fitting a complete discussion into a single paragraph can create unnecessary stress. Instead, use two or three paragraphs to provide a comprehensive understanding of your study. Here's a suggested structure for an effective discussion:

### First paragraph

- Provide the essential interpretation based on key findings
- Include a main piece of supporting evidence



### Second paragraph

- Compare and contrast to previous studies
- Highlight the strengths and limitations of the study
- Discuss any unexpected findings



### Last paragraph

- Summarize the hypothesis and purpose of the study
- Highlight the significance of the study
- Discuss unanswered questions and potential future research