

IMRAD

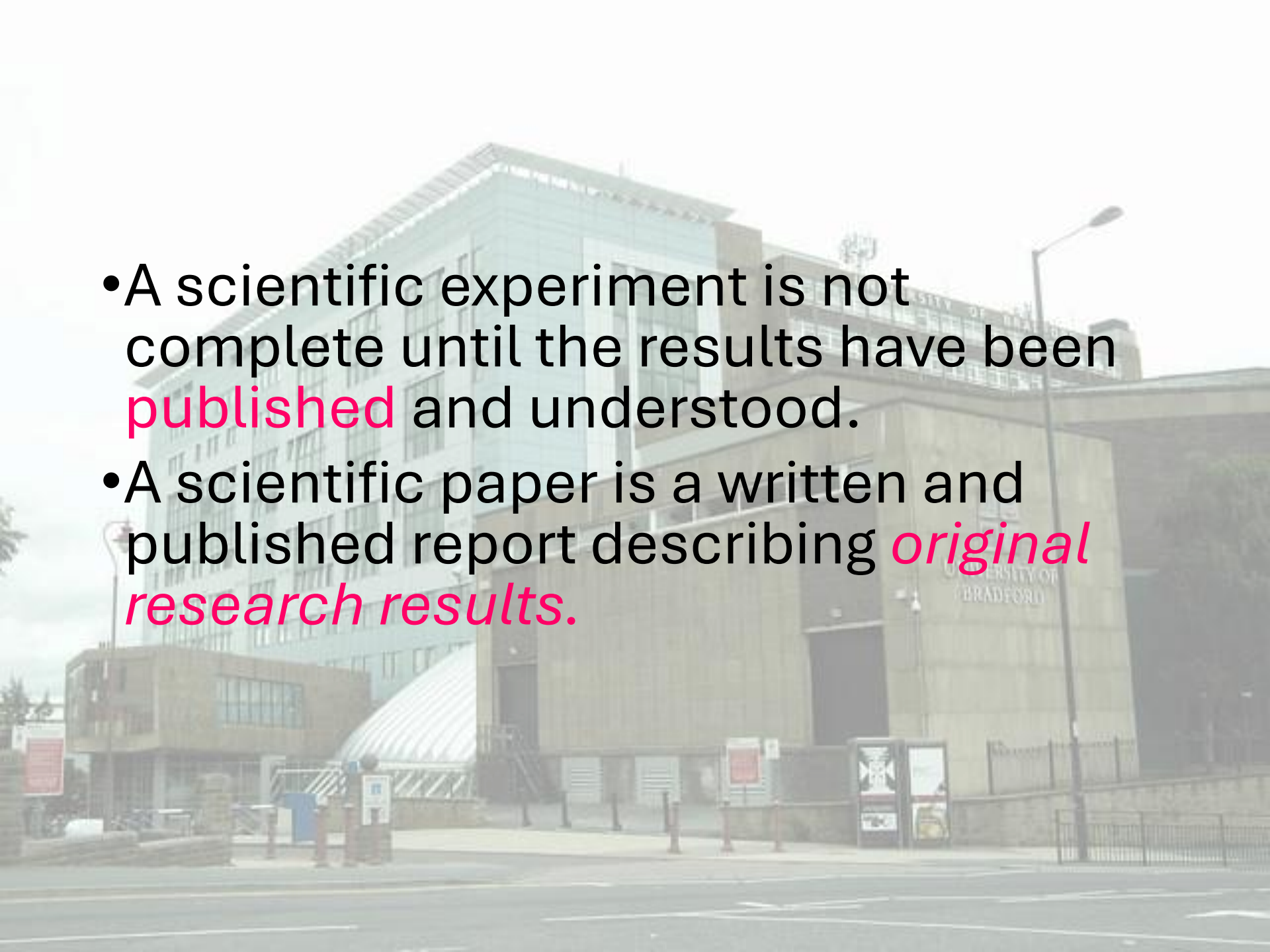
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DARMAJAYA

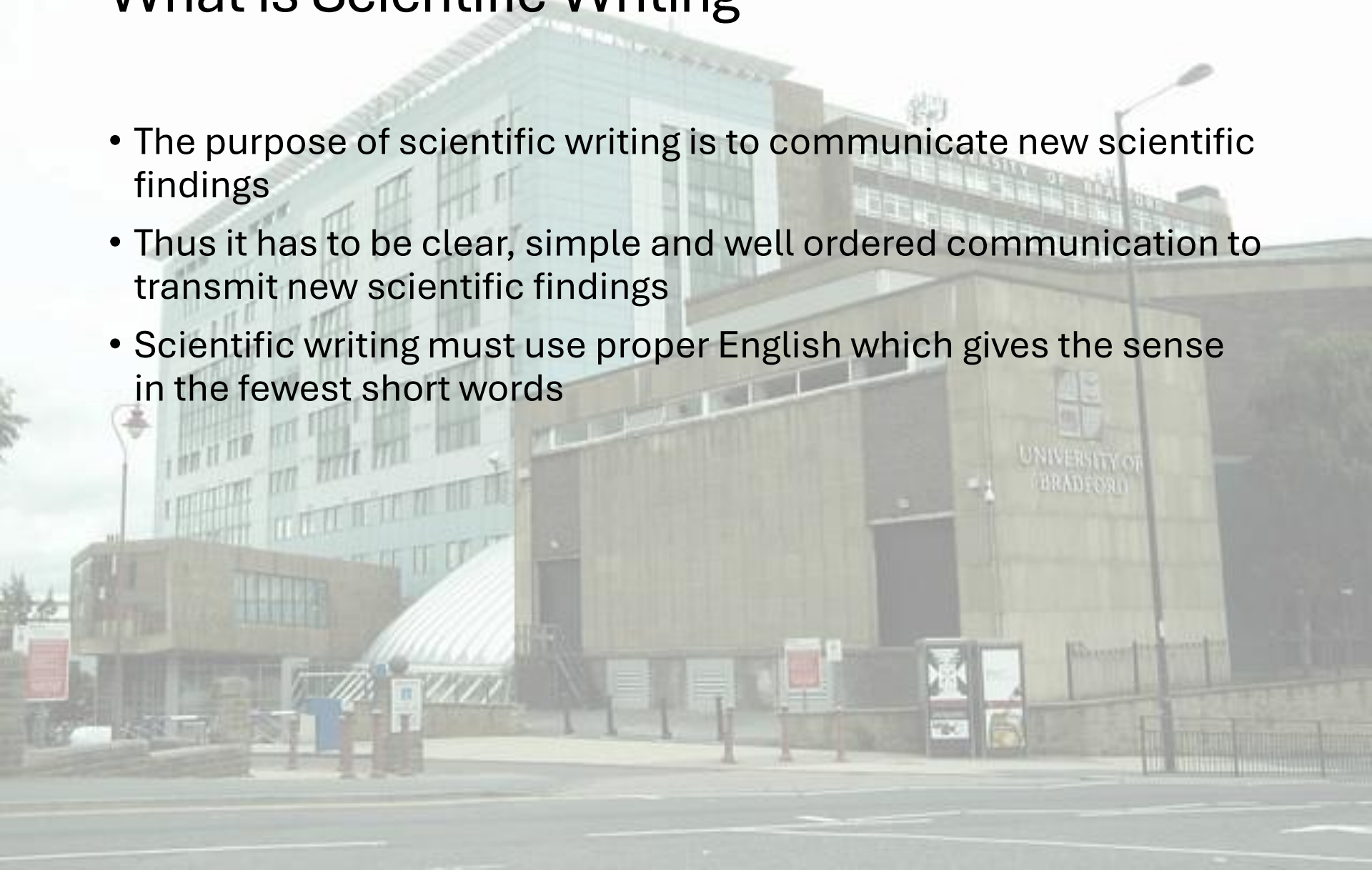
8 November 2025



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- A photograph of a large, multi-story university building with a modern architectural style. The building has a mix of brick and lighter-colored panels. The words "UNIVERSITY OF BRADFORD" are visible on the upper part of the facade. In the foreground, there is a paved area with some utility boxes and a fence. The sky is overcast.
- A scientific experiment is not complete until the results have been **published** and understood.
 - A scientific paper is a written and published report describing *original research results*.

What is Scientific Writing

- The purpose of scientific writing is to communicate new scientific findings
- Thus it has to be clear, simple and well ordered communication to transmit new scientific findings
- Scientific writing must use proper English which gives the sense in the fewest short words



Origins of Scientific Writing

- Knowledge is lost without written records
- Cave paintings and inscriptions were the first attempts to leave records
- About 2000 BC, Papyrus paper was used as a medium of communication
- In 190 BC, parchment made from animal skin came into use
- In 105 AD, the Chinese invented paper
- Knowledge could not be widely circulated with no effective duplication
- In 1100 AD, the Chinese invented movable type
- In 1455 AD, Gutenberg printed his 42-line Bible from movable type on a printing press
- By the year 1500 thousands of copies of hundreds of books (called “incunabula”) were printed
- In 1665, the first scientific journals were published

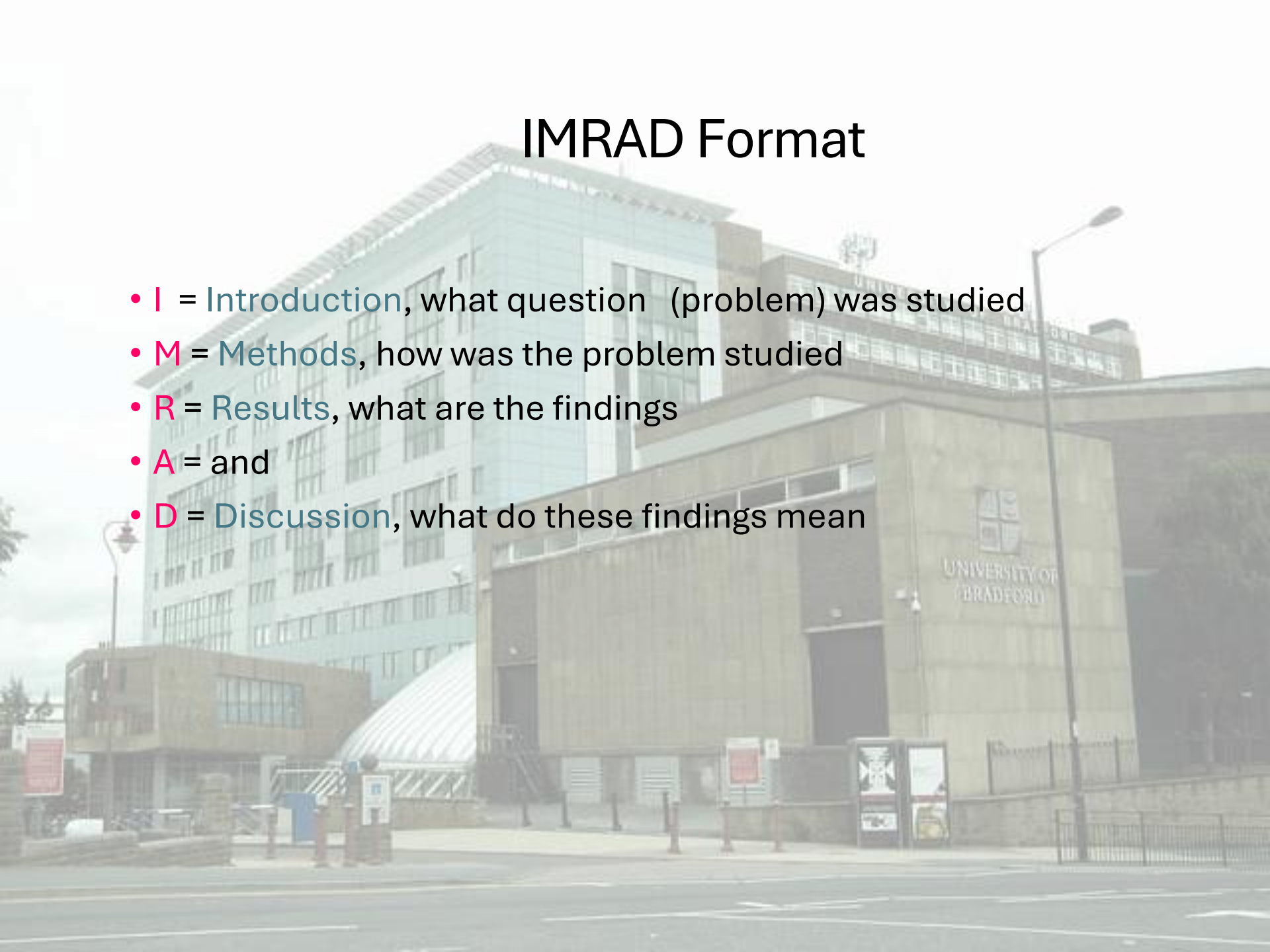
IMRAD Story

(Introduction, Methods, Results and Discussion)

- Early journals published **descriptive** papers (still used in case reports, geological surveys etc..)
- By the second half of the 19th century, **reproducibility of experiments** became a fundamental principle of the philosophy of science.
- The **methods section** became all important since Louis Pasteur confirmed the germ theory of disease
- IMRAD organization of a scientific paper started to develop
- IMRAD format slowly progressed in the latter half of the 19th century

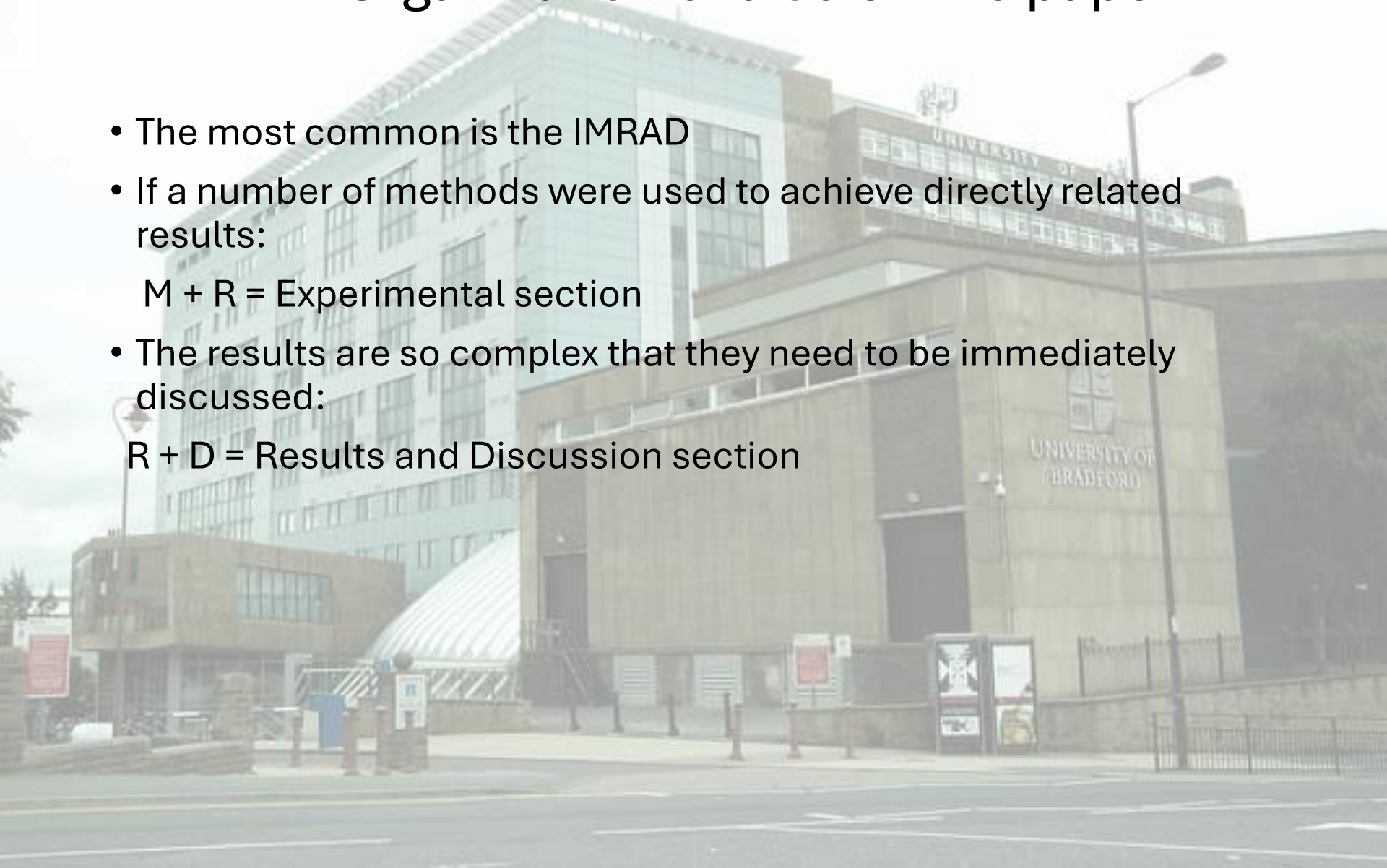
IMRAD Format

- **I** = Introduction, what question (problem) was studied
- **M** = Methods, how was the problem studied
- **R** = Results, what are the findings
- **A** = and
- **D** = Discussion, what do these findings mean



Organization of a scientific paper

- The most common is the IMRAD
- If a number of methods were used to achieve directly related results:
M + R = Experimental section
- The results are so complex that they need to be immediately discussed:
R + D = Results and Discussion section



What is a scientific paper

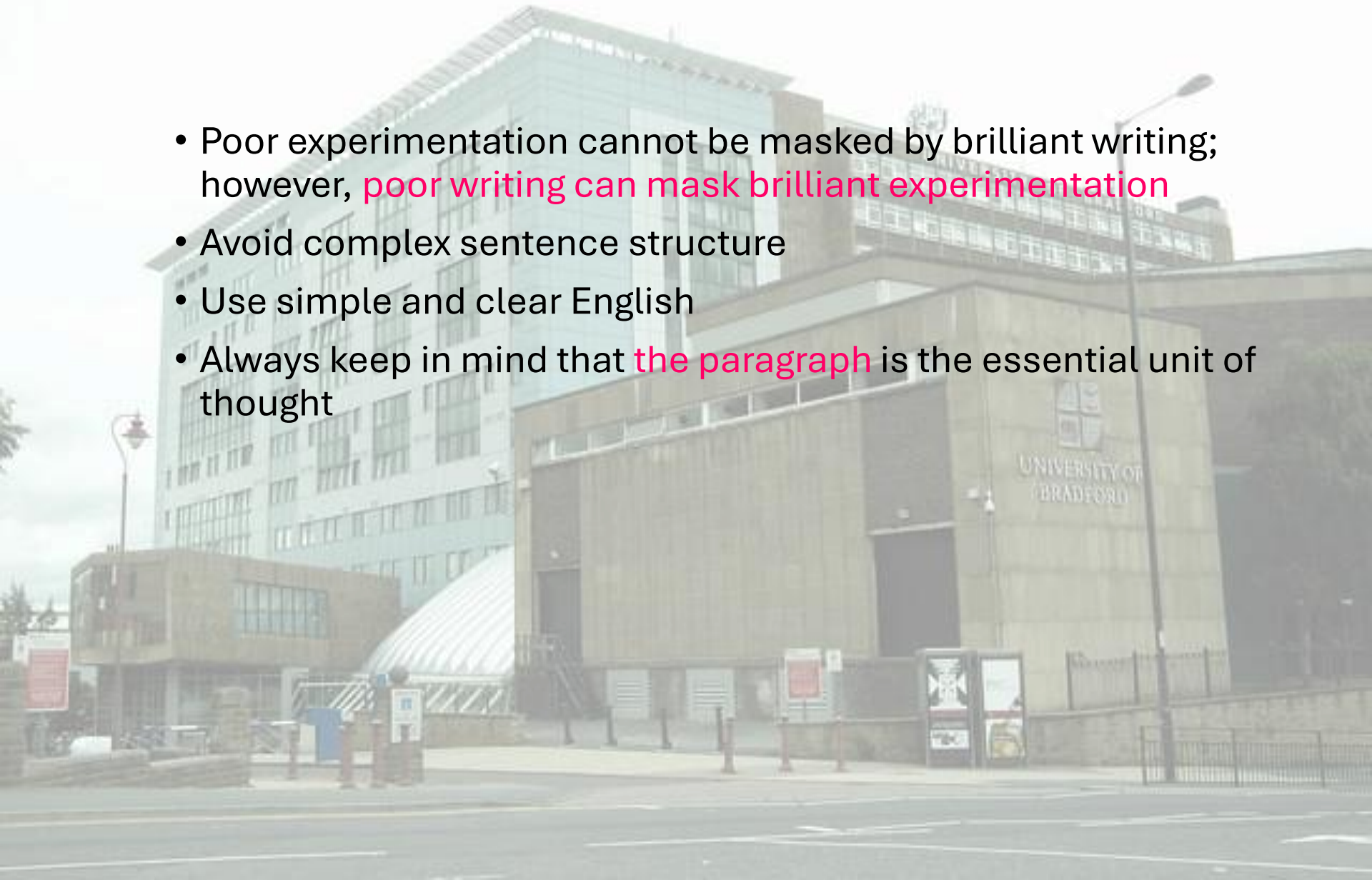
- A scientific paper is a written and published report describing original research results.
 1. It must be the first publication of original research results,
 2. In a form whereby peers of the author can repeat the experiments and test the conclusions, and
 3. In a journal or other source document readily available within the scientific community

Definition of Scientific paper

- An accepted original scientific publication containing scientific information to enable peers:
 1. To assess observations
 2. To repeat experiments
 3. To evaluate intellectual processes
 4. Must have an impact
 5. Available to scientific community without restriction
 6. Available for regular screening by one or more of the major recognized secondary services (Biological abstracts, Index Medicus, Pub Med etc...)

Some important Language points:

- Poor experimentation cannot be masked by brilliant writing; however, **poor writing can mask brilliant experimentation**
- Avoid complex sentence structure
- Use simple and clear English
- Always keep in mind that **the paragraph** is the essential unit of thought



Before Starting to Write the Paper

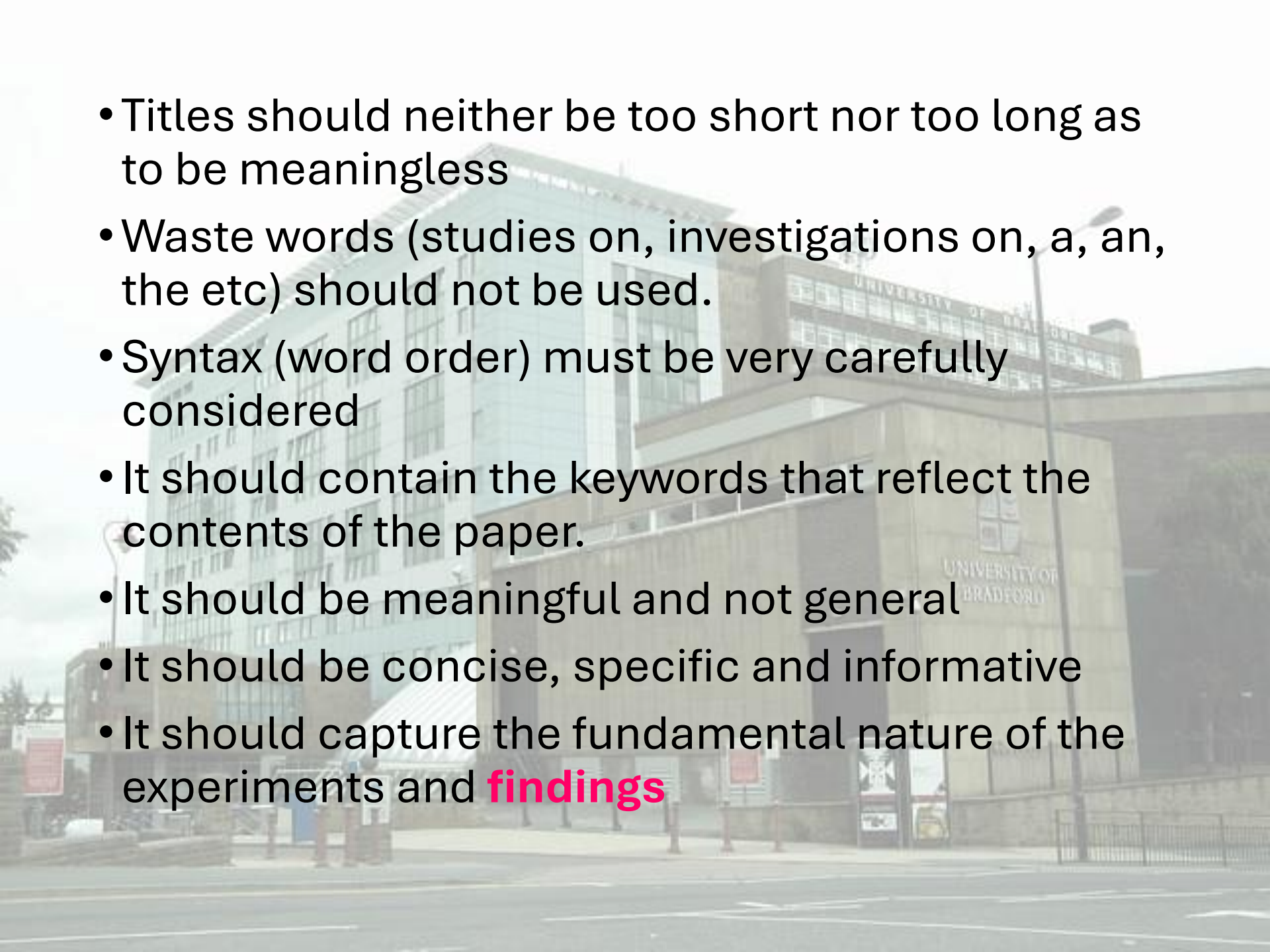
- Record your readings (results)
- Make tables
- Draw graphs
- Keep file to record summaries of results and any observation however insignificant
- Date the files
- Revise your readings, you may need to repeat an experiment while you still have the materials.
- Write ideas when ever they come to you

Essential Parts of a Scientific paper

- **Title**: Describe concisely the core contents of the paper
- **Abstract**: Summarize the major elements of the paper
- **Introduction**: provide context and rationale for the study
- **Materials**: Describe the experimental design so it is reproducible
- **Methods**: Describe the experimental procedures
- **Results**: Summarize the findings without interpretation
- **Discussion**: Interpret the findings of the study
- **Summary**: Summarize the findings
- **Acknowledgement**: Give credit to those who helped you
- **References**: List all scientific papers, books and websites that you cited

The Title

- A good title is defined as the fewest possible words that **adequately describe** the contents of the paper.
- The title is extremely important and must be chosen with great care as it will be read by thousands, whereas few will read the entire paper
- Indexing and abstracting of the paper depends on the accuracy of the title. An improperly titled paper will get lost and will never be read.

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- A faded background image of a large, multi-story university building with many windows. The words "UNIVERSITY OF BRADFORD" are visible on the upper part of the building's facade.
- Titles should neither be too short nor too long as to be meaningless
 - Waste words (studies on, investigations on, a, an, the etc) should not be used.
 - Syntax (word order) must be very carefully considered
 - It should contain the keywords that reflect the contents of the paper.
 - It should be meaningful and not general
 - It should be concise, specific and informative
 - It should capture the fundamental nature of the experiments and **findings**

Examples

1. Action of Antibiotics on Bacteria
 - Action: should be defined
 - Antibiotics: should be listed
 - Bacteria: should be listed
2. Mechanism of Suppression of Nontransmissible Pneumonia in Mice Induced by Newcastle Disease Virus
3. Evaluation of the methylation status of the promoter of prostate apoptosis par-4 gene and its protein expression in Egyptian cancer patients
4. Effect of sunlight on leaf morphology

How to Prepare the Title

- Make a list of the most important keywords
- Think of a title that contains these words
- The title could state the conclusion of the paper
- The title **NEVER** contains abbreviations, chemical formulas, proprietary names or jargon
- Think, rethink of the title before submitting the paper
- Be very careful of the grammatical errors due to faulty word order
- Avoid the use of the word “using”

The Abstract

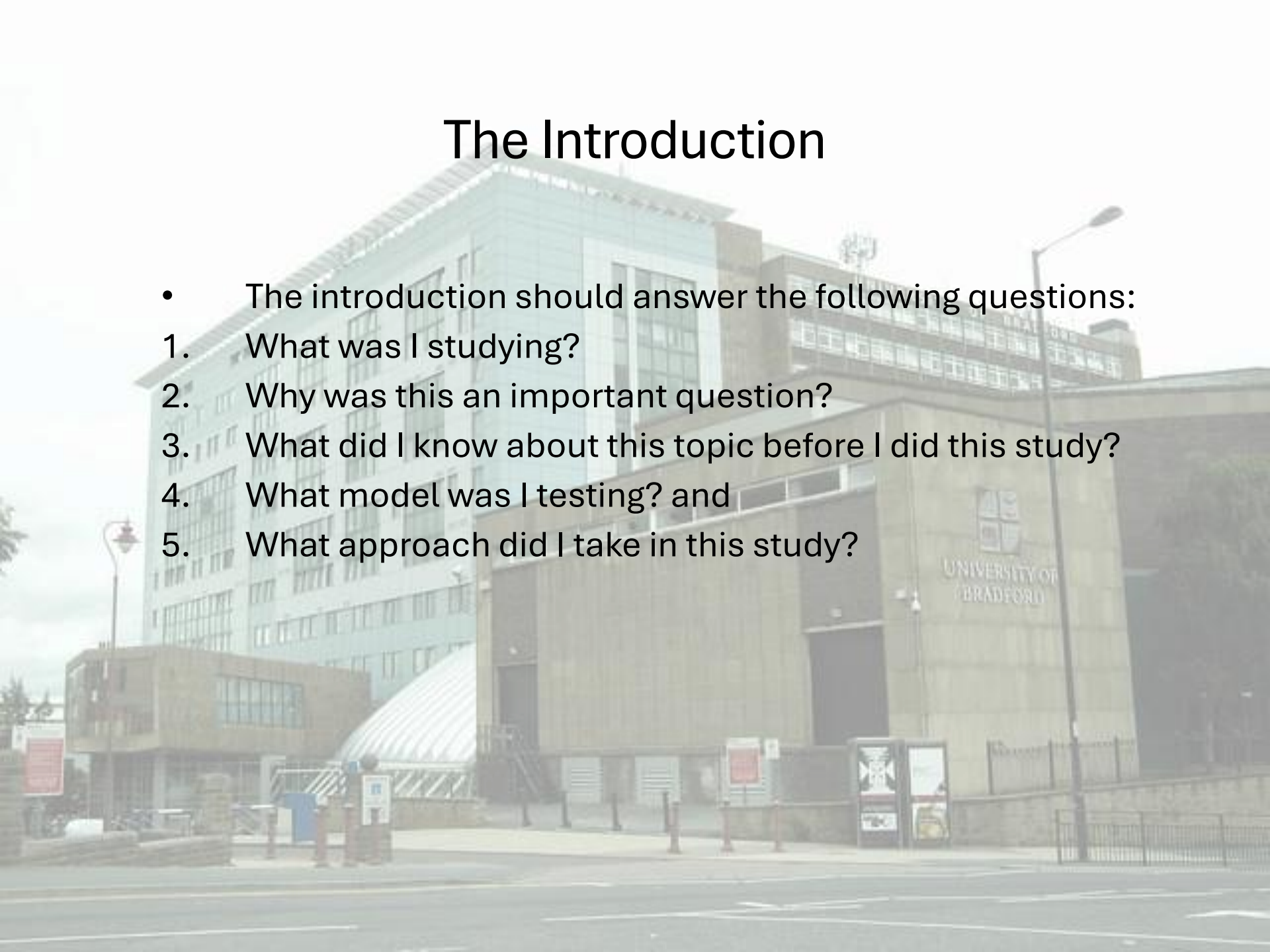
- An abstract can be defined as a summary of the information in a document
- It is of fundamental importance that the abstract be written clearly and simply, as it is the first and sometimes the only part of the manuscript read.
- It should provide a brief summary of each of the main sections (IMRAD) of the paper:
 1. State the principal objective and scope of the investigation
 2. Describe the methods used
 3. Summarize the results, and
 4. State the principal conclusions
- It is easier to write the abstract after completion of the paper

Criteria of the Abstract

- It should not exceed 250 words
- It should be written in one paragraph.
- It should be written in the past tense as it refers to work done.
- Long words should be followed by its abbreviation which would be used through out the abstract and paper.
- It should not cite any references (except in rare cases)
- It should never give any information or conclusion that is not stated in the paper
- Must be accurate with respect to figures quoted in the main text.

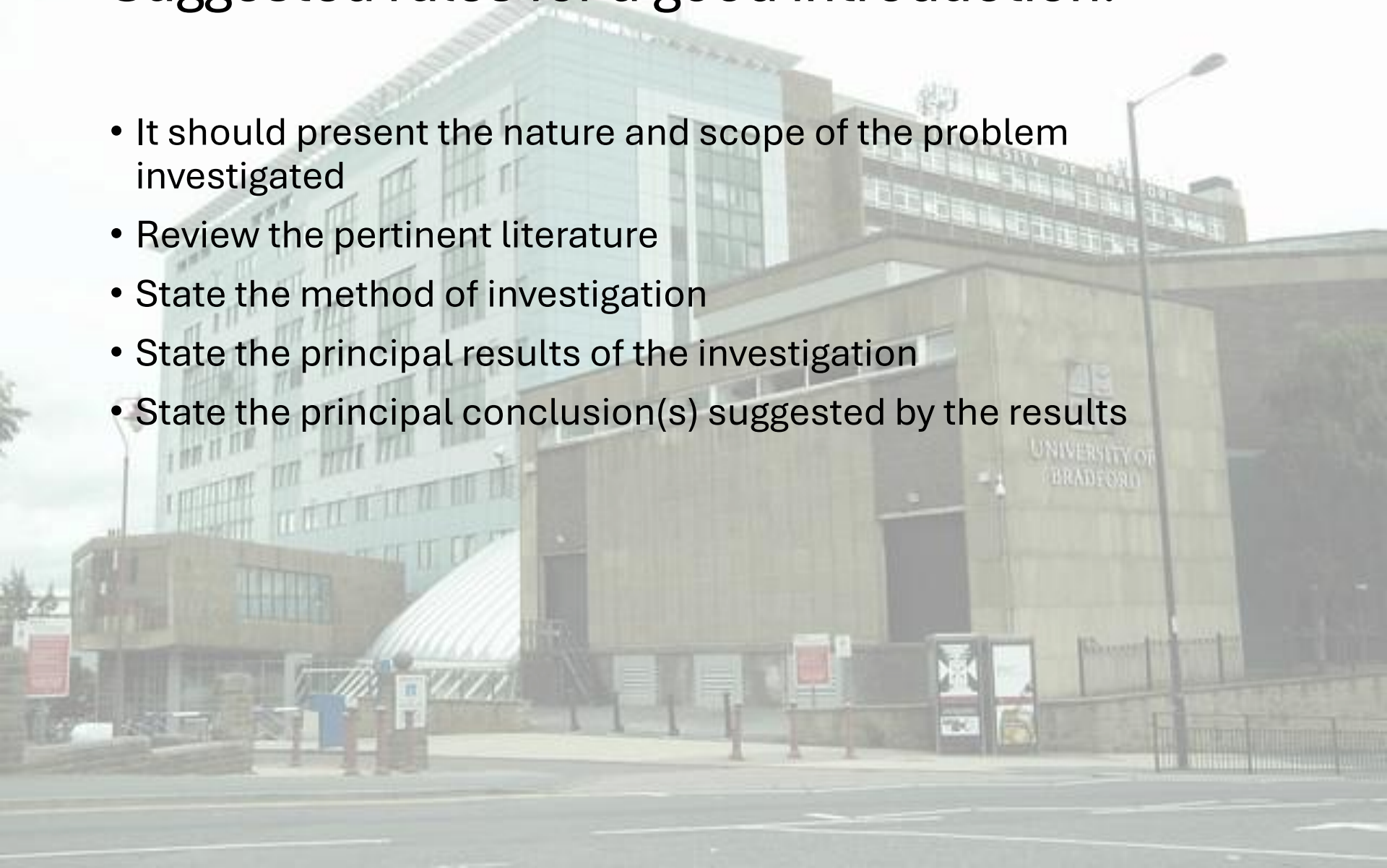
The Introduction

- The introduction should answer the following questions:
 1. What was I studying?
 2. Why was this an important question?
 3. What did I know about this topic before I did this study?
 4. What model was I testing? and
 5. What approach did I take in this study?



Suggested rules for a good introduction:

- It should present the nature and scope of the problem investigated
- Review the pertinent literature
- State the method of investigation
- State the principal results of the investigation
- State the principal conclusion(s) suggested by the results



General rules

- Use the present tense when referring to work that has already been published, but past tense when referring to your own study.
- Use the active voice as much as possible
- Avoid lengthy or unfocused reviews of previous research.
- Cite peer-reviewed scientific literature or scholarly reviews. Avoid general reference works such as textbooks.
- Define any specialized terms or abbreviations

How to write the Materials and Methods section

- Provide full details so that the experiments are reproducible
- If the peer reviewer has doubts that the experiments could be repeated, the manuscript will be rejected.
- Organize the methods under subheadings, with related methods described together (e.g. subjects, experimental design, Measurement of..., Hormonal assays etc...).
- Describe the experimental design in detail
- Do *not* mix some of the Results in this section
- Write in the past tense

Materials

- Must identify accurately experimental animals, plants, and microorganisms used by genus, species and strain
- The source of subjects studied, number of individuals in each group used, their sex, age, and weight must be clearly stated
- If human subjects are used, the criteria for selection should be described, and consent
- For chemicals used, include exact technical specifications and source or method of preparation.
- Avoid the use of trade names of chemicals, generic or chemical names are preferred.

Methods

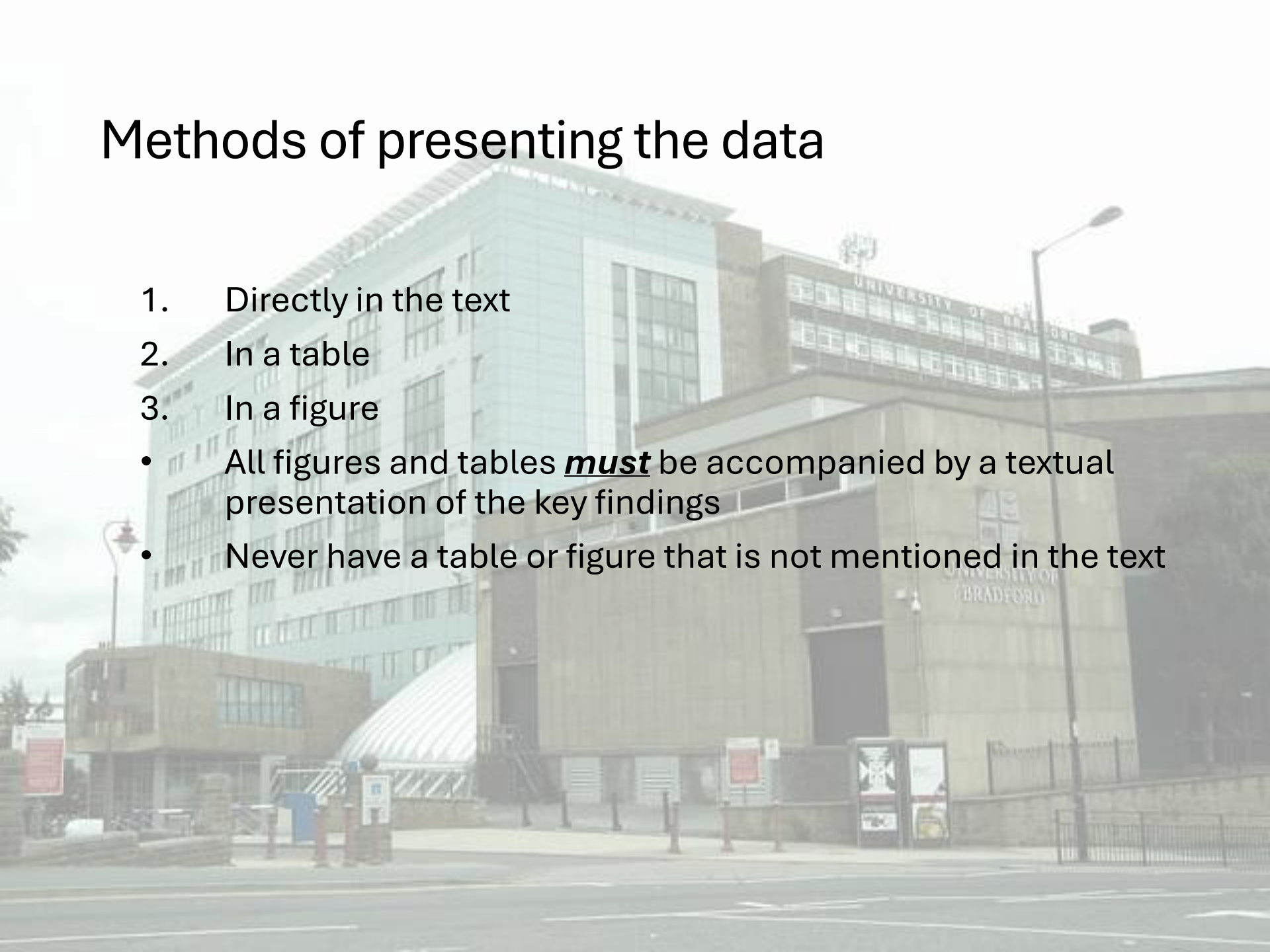
- This part of the manuscript must be clear, precise and concise so that it can be reproducible
- If the method is new, ***all*** details must be provided
- If the method has been previously published in a scientific journal, only the reference should be given with some identification:
e.g. “cells were broken by ultrasonic treatment as previously described by ...”. Preferable than “cells were broken as previously described by “
- Questions such as “how” or “how much” must be answered and not left to be puzzled over
- Methods used for statistical analyses must be mentioned; ordinary ones without comments, but advanced or unusual ones require literature citation

How to write the Results

- Results section is written in the past tense
- It is the core or heart of the paper
- It needs to be clearly and simply stated since it constitutes the new knowledge contributed to the world
- The purpose of this section is to summarize and illustrate the findings in an orderly and logical sequence, without interpretation
- The text should guide the reader through the findings, stressing the major points
- Do not describe methods that have already been described in the M&M section or that have been inadvertently omitted

Methods of presenting the data

1. Directly in the text
2. In a table
3. In a figure
 - All figures and tables ***must*** be accompanied by a textual presentation of the key findings
 - Never have a table or figure that is not mentioned in the text

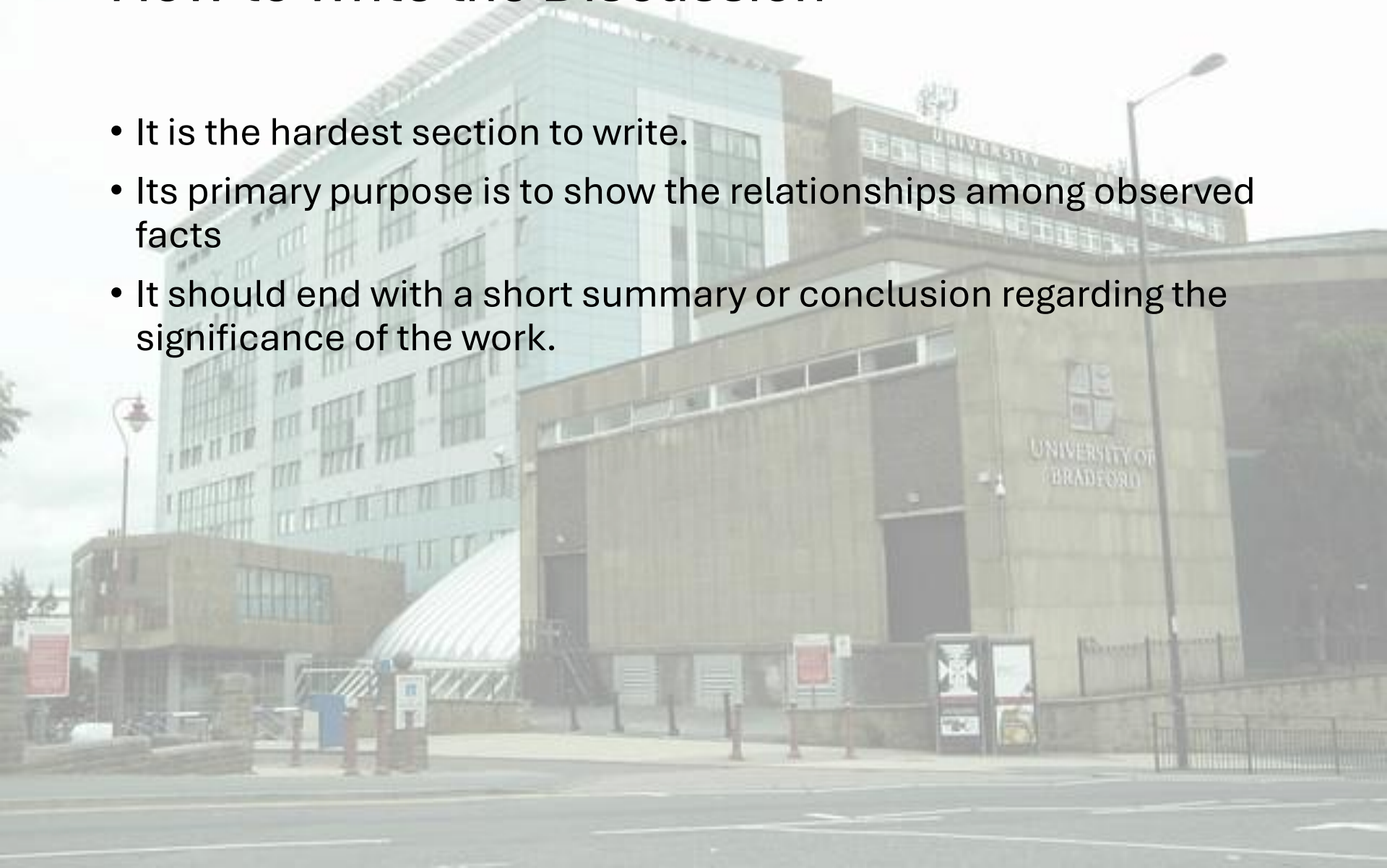


Tables and figures

- Tables are appropriate for large or complicated data sets that would be difficult to explain clearly in text.
- Figures are appropriate for data sets that exhibit trends, patterns, or relationships that are best conveyed visually.
- Any table or figure must be sufficiently described by its title and caption or legend, to be understandable without reading the main text of the results section.
- Do not include both a table and a figure showing the same information

How to write the Discussion

- It is the hardest section to write.
- Its primary purpose is to show the relationships among observed facts
- It should end with a short summary or conclusion regarding the significance of the work.



Components of the discussion

- Try to present the principles, relationships, and generalizations shown by the Results
- Point out any exceptions or any lack of correlation and define unsettled points
- Show how your results and interpretations agree or contrast with previously published work
- Discuss the theoretical implications of your work, and any possible practical applications.
- State your conclusions as clearly as possible
- Summarize your evidence for each conclusion

How to State the Acknowledgments

- You should acknowledge:
 1. Any significant technical help that you have received from any individual in your lab or elsewhere
 2. The source of special equipment, cultures, or any other material
 3. Any outside financial assistance, such as grants, contracts or fellowships
- Do not use the word “wish”, simply write “I thank” and not “I wish to thank...”
- Show the proposed wording of the Acknowledgement to the person whose help you are acknowledging

References

What is referencing?

- Referencing is a standardized way of acknowledging the sources of information and ideas that you have used in your document.
- A list of ALL the references used in the text must be written.
- Reference format varies widely:
 - **Harvard format** (the name and year system) is the most widely used
 - Alphabet-Number system is a modification of name and year system
 - Citation order system

In-text citations

In name and year system:

- Citation in the text is followed by the author's last name and year of publication between parentheses.
 - If they were two authors then both last names are written.
 - If more than two then the only first author's name is written followed by the abbreviation *et al*
- If a single statement requires more than one citation then the references are arranged chronologically from oldest to more recent, separated by semicolons.
 - If more than one reference share the same year then they are arranged alphabetically within the year.

In alphabet-number system:

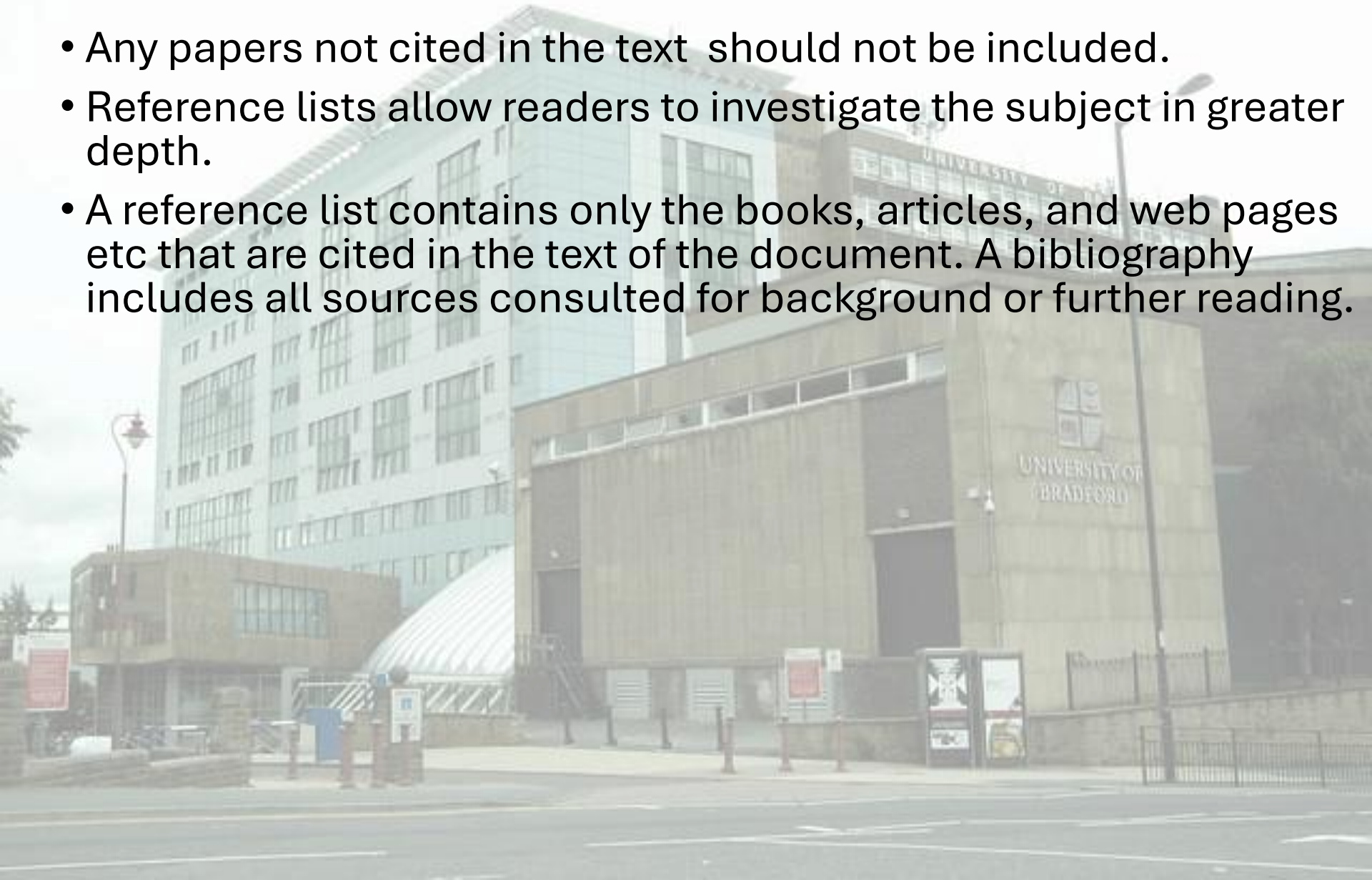
- Citation by number from an alphabetically arranged numbered reference list.

In Citation order system:

- The references are numbered in the order they are mentioned in the text

Reference List

- Any papers not cited in the text should not be included.
- Reference lists allow readers to investigate the subject in greater depth.
- A reference list contains only the books, articles, and web pages etc that are cited in the text of the document. A bibliography includes all sources consulted for background or further reading.



In name and year system:

- The reference list is arranged alphabetically by author. If an item has no author, it is cited by title, and included in the alphabetical list using the first significant word of the title.
- If more than one item has the same author, list the items chronologically, starting with the earliest publication.
- Each reference appears on a new line.
- There is no indentation of the references
- There is no numbering of the references

In alphabet-number system:

It the same as above in addition each reference is given a number

In Citation order system:

The reference list is arranged by the number given to the citation by the order that it were mentioned in the text

- **Book**

- 1. Okuda M, Okuda D. *Star Trek Chronology: The History of the Future*. New York: Pocket Books; 1993.

- **Journal or Magazine Article (with volume numbers)**

- 2. Wilcox RV. Shifting roles and synthetic women in Star trek: the next generation. *Stud Pop Culture*. 1991;13:53-65.

- **Newspaper, Magazine or Journal Article (without volume numbers)**

- 3. Di Rado A. Trekking through college: classes explore modern society using the world of Star trek. *Los Angeles Times*. March 15, 1995:A3.

- **Encyclopedia Article**

- 4. Sturgeon T. Science fiction. In: Lorimer LT, editorial director; Cummings C, ed-in-chief; Leish KW, managing ed. *The Encyclopedia Americana*. Vol 24. International ed. Danbury, Conn: Grolier Incorporated; 1995:390-392.

- **Book Article or Chapter**

- 5. James NE. Two sides of paradise: the Eden myth according to Kirk and Spock. In: Palumbo D, ed. *Spectrum of the Fantastic*. Westport, Conn: Greenwood; 1988:219-223.

- **ERIC Document**

- 6. Fuss-Reineck M. *Sibling Communication in Star Trek: The Next Generation: Conflicts Between Brothers*. Miami, Fla: Annual Meeting of the Speech Communication Association; 1993. ERIC Document Reproduction Service ED364932.

- **Website**

- 7. Lynch T. DSN trials and tribble-ations review. Psi Phi: Bradley's Science Fiction Club Web site. 1996. Available at: <http://www.bradley.edu/campusorg/psiphi/DS9/ep/503r.htm>. Accessed October 8, 1997.

- **Journal Article on the Internet**

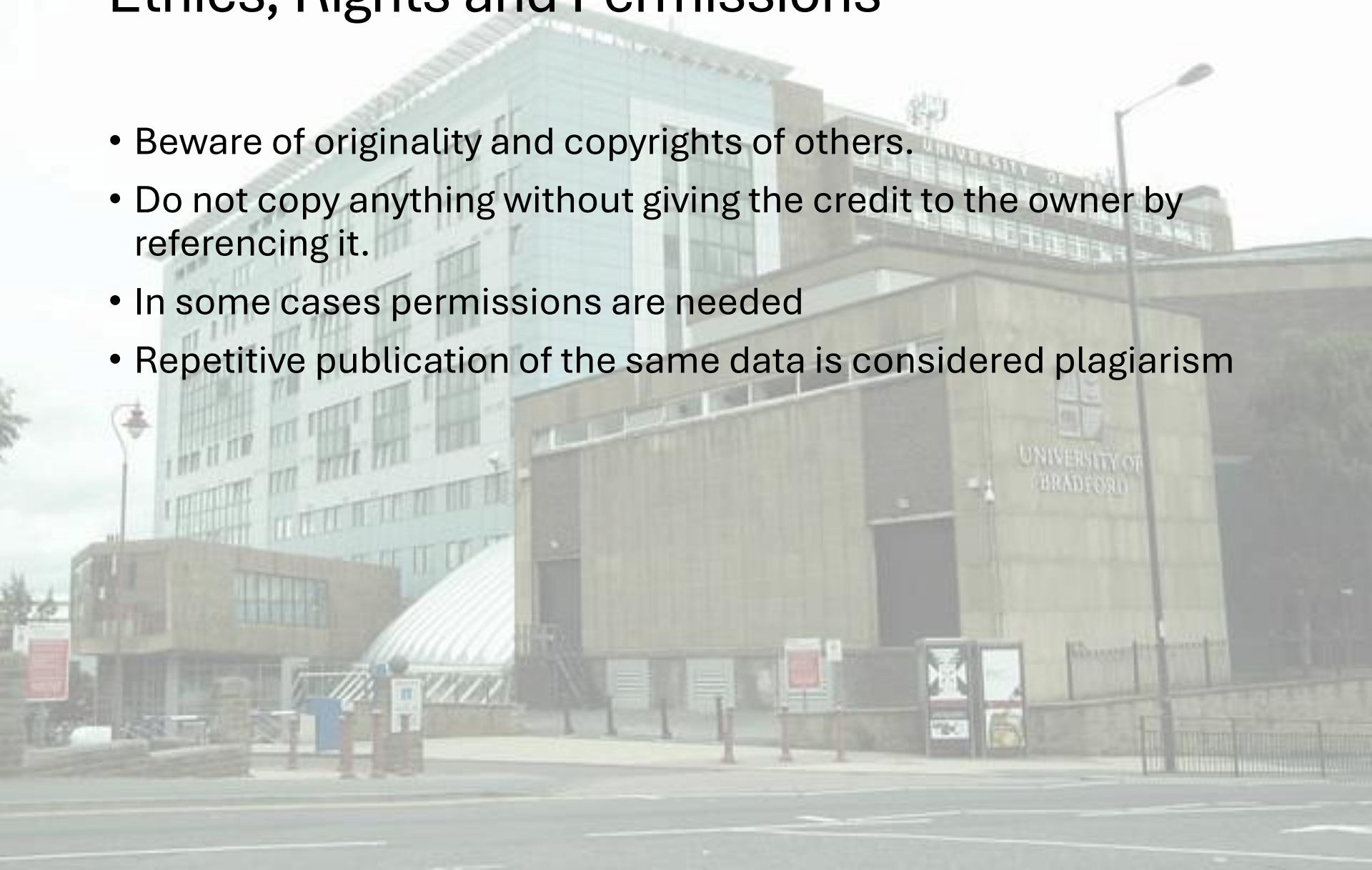
- 8. McCoy LH. Respiratory changes in Vulcans during pon farr. *J Extr Med* [serial online]. 1999;47:237-247. Available at: http://infotrac.galegroup.com/itweb/nysl_li_liu. Accessed April 7, 1999.

How to Write a Thesis

- A PhD thesis in the science is supposed to present the candidate's original research i.e. it is a scientific paper
- Unlike the scientific paper, the thesis may describe more than one topic, and it may present more than one approach to some topics.
- The thesis may present all or most of the data obtained in the student's thesis related research.
- Thus it is more involved and longer than a scientific paper.
- Think of a thesis as a good thriller, and write in a logical way so that a reader will find it interesting and will not be bored.

Ethics, Rights and Permissions

- Beware of originality and copyrights of others.
- Do not copy anything without giving the credit to the owner by referencing it.
- In some cases permissions are needed
- Repetitive publication of the same data is considered plagiarism



References

- Robert Day (1995): How to write and publish a scientific paper. 4th Edition, Cambridge University Press
- University of Queensland (2009) *References/Bibliography Harvard Style*

http://www.library.uq.edu.au/training/citation/harvard_6.pdf

