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Faculty of natural sciences and life

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Department of Basic Studies

Handout of

Work Methodology and Terminology







Intended for 1st year biology students

Presented by **Dr. Ghedjati Nadra**

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Introduction

Science is more than just facts or knowledge; it is a way of understanding the world. Every day, new evidence and insights emerge from undertaking research. The scientific method is a systematic process and set of procedures that help us do research.

Scientific research is based on systematic and rigorous methods to produce reliable and valid knowledge. Understanding and applying these methods is essential not only for successfully carrying out their own research projects but also for interpreting and critically evaluating the work of other researchers. Moreover, mastering scientific terminology is crucial for communicating ideas with precision and clarity in both academic and professional contexts.

The Work Methodology and Terminology module establishes the essential foundations for developing a deep understanding of scientific methodology and specialized terminology. This module is designed to provide students with the tools and skills necessary to conduct rigorous research, communicate their results effectively, and navigate confidently in the complex world of scientific vocabulary.

The Work Methodology and Terminology module aims to provide students with the essential skills in research methods, academic writing, and scientific language needed to produce clear, well-organized, and reliable academic work.

1 Introduction to bibliographic research

1.1Bibliographic research definition

Bibliographic research is a fundamental step in developing research. It is the set of steps allowing you to search, identify and find documents relating to a subject by developing a search strategy. This reading process allows you to know what have been done on a subject, how it was done and what has not yet been done.

1.2 Definition of a document

A document is an object that carries information. It can be a book, a periodical article, an audio or audiovisual document. The document, a vehicle of information, is found in different media.

Support: material nature of the document (paper, digital, etc.)

Ex: Encyclopedia in paper version/ Encyclopedia in digital version (Larousse).

Documentary resources: this is any support containing information such as books, magazines, plates, audio and video cassettes, CDs and DVDs as well as the internet.







1.3 The main stages of bibliographic research

There are different methods for defining a good bibliographic research strategy, but they are always based on a few key principles. It will be structured around six successive stages:

Step 1: Identify the subject

-Define terms,

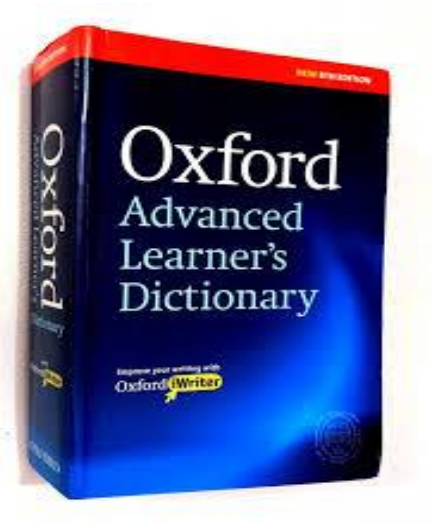
-Understand concepts, identify concepts,

-Define the limits of the subject (avoid going off-topic),

-Master the subject (vocabulary, objectives, etc.).

For that:

1) Use a dictionary, look up the definition of words that you do not know or you are not sure of their meaning. You can also search in an encyclopedia to get a first overview of the subject.



2) Use the **WWWWHW** method: This is a mnemonic means allowing you to remember a set of simple questions which will be used to identify, clarify and deepen a subject:

1 **Who?** = Who are the actors, the people involved?
2 **What?** = What aspects interest me?
3 **When?** = What is the period concerned?
4 **Where?** = Is the subject limited to a specific geographical area?
5 **How?** = What approaches or points of view should be considered? (historical, sociological, economic, political, etc.)
6 **Why?** = How important is the subject in the current context?



3) Identify topic keywords. What are the essential words or expressions to understand the subject? Find 5 at most.



Step 2: Find sources

After analyzing and delimiting the subject, you must choose the best sources of information to carry out the documentary research. This approach includes two dimensions:

- **The type of documents** we are looking for: monographs, journal articles, theses, etc.
- **The type of resources** to query: library catalogs, databases, web search engine, specialized portals, etc.

1-Types of documents: corresponds to the **level** and **nature** of the information sought

a. General or specialized dictionaries and encyclopedias (paper or electronic) useful for understanding and clarifying the subject, especially when new concepts are involved.

b. books or monographs (complete study on a specific subject), useful for further research and are included in this category:

- Manuals, which provide an overview of a question.
- Précis, which go into greater depth on a particular aspect of a subject
- Mementos (notices summarizing the essentials of a subject that should not be forgotten), which provide a quick overview of a topic.
- Colloquium proceedings, which are the proceedings of a conference on a given subject.

c. Scientific publications giving the latest research results or news.

d. theses, dissertations, research reports

e. specific documents (maps, patents, images, statistical data, etc.): their use will depend on the field chosen to treat a subject.

f. official documentation: all official documents published by the State (laws, decrees, etc.).

2- Type of resources: It will depend on the **nature** of the subject and the **type** of document sought:

1. Library catalogs: multidisciplinary, they are essential for finding paper documentation:

- University union catalog (SUDOC: http://www.sudoc.abes.fr)
- World catalog (Worldcat: http://www.worldcat.org/)

2. Bibliographic databases

A database is a collection of information that is organized so that it can be easily accessed, managed and updated. It is used by organizations as a method of storing, managing and retrieving information. They consist of a structured set of bibliographic references on a subject, a field, a type of document, etc. They can contain an analysis, a summary and increasingly often access to the full text of the document itself.

Based on coverage, they may be multidisciplinary, specialized, or highly specific. Some are global, while others are regional.

Access can be: **free** or **subscription-based**.

The 5 main bibliographic databases are:

Web of Science: Discipline: multidisciplinary, Access options: institutional subscription only (fig. 1).

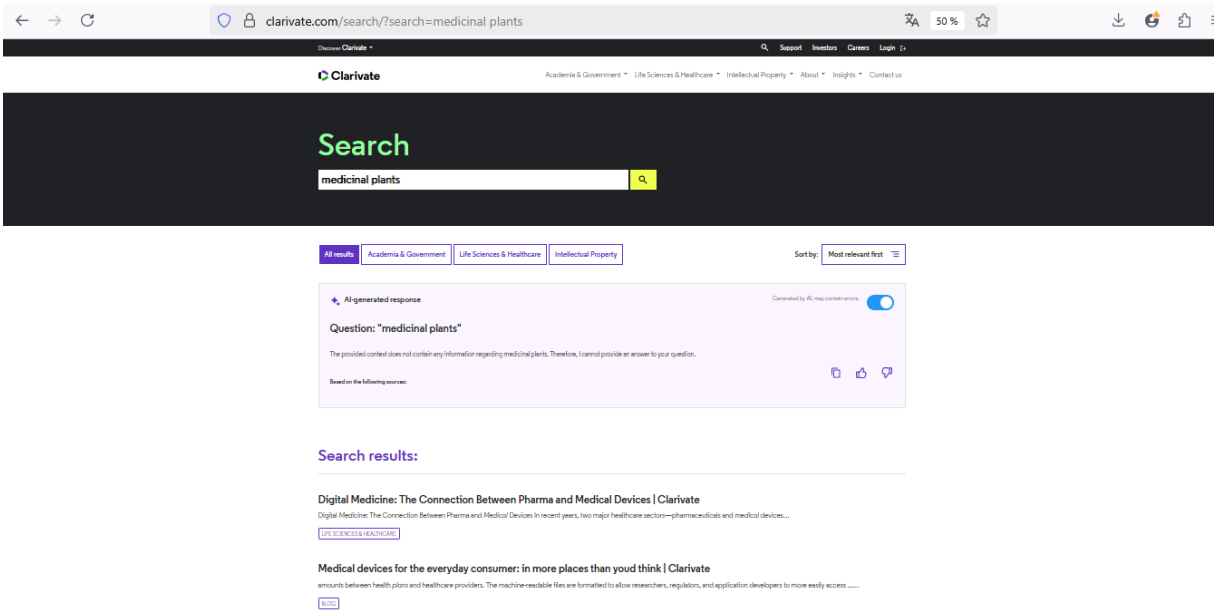


Figure 1: Web of Science search results page displaying articles on medicinal plants for example.

Scopus: multidisciplinary, limited free preview, full access only by institutional subscription (fig. 2)

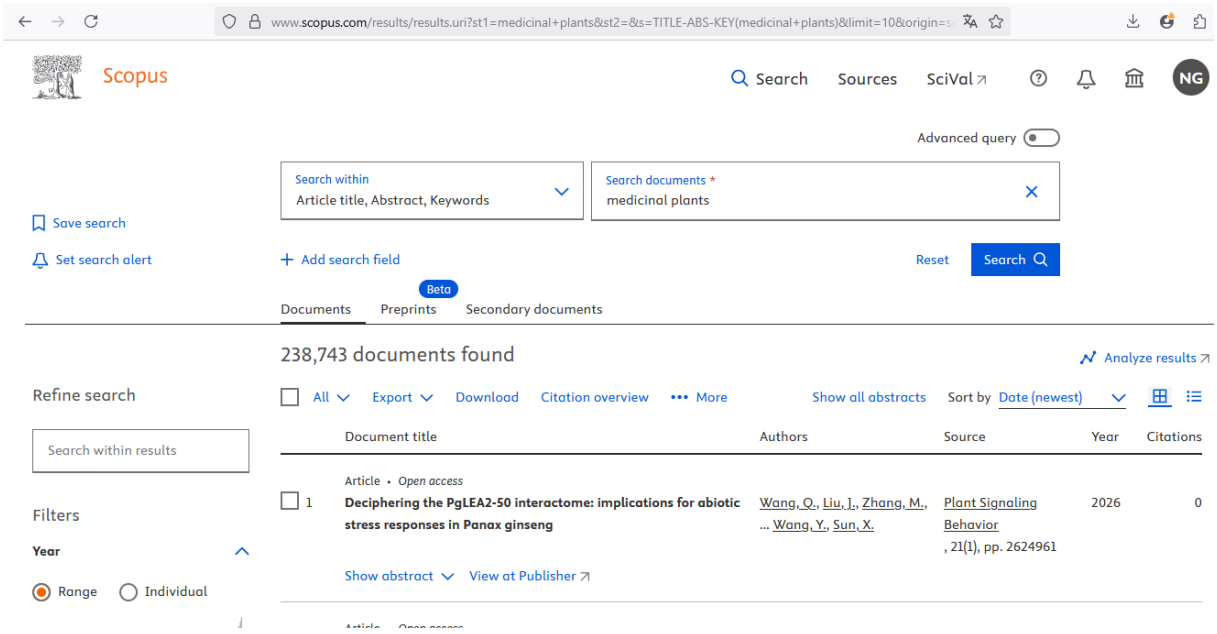


Figure 2: Scopus database search results for "medicinal plants" as an example.

PubMed: Discipline: medicine, biological sciences, Access possibilities: free (fig. 3).

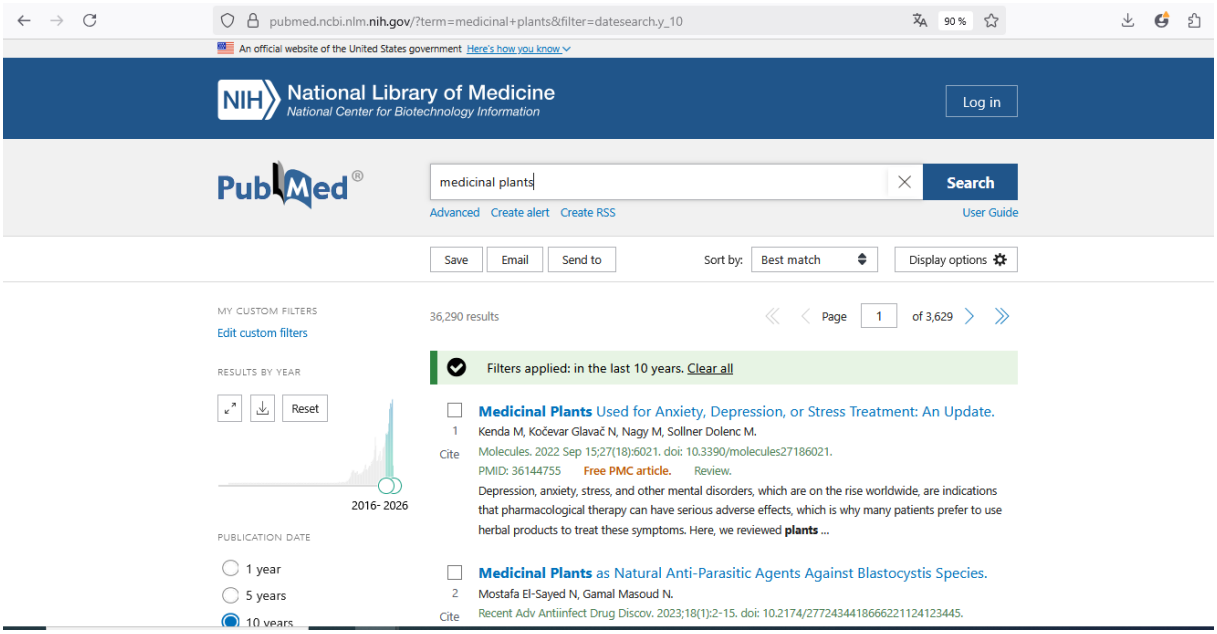


Figure 3:PubMed database search results for "medicinal plants" as an example.

Science Direct: Discipline: multidisciplinary, Access possibilities: free (fig.4).

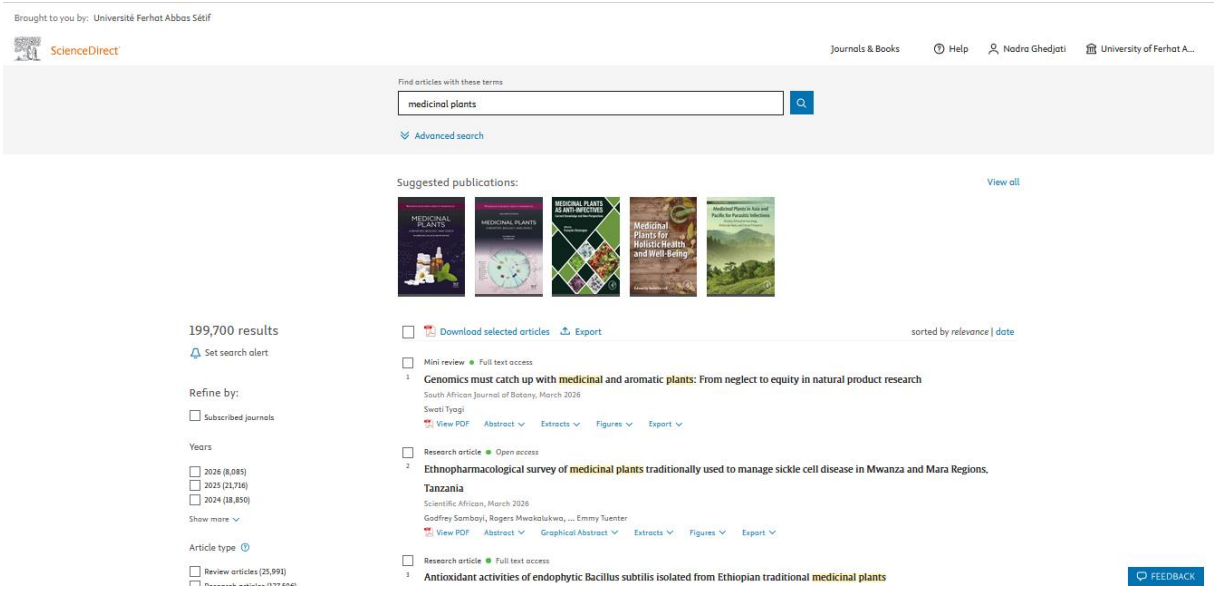


Figure 4: Science Direct database search results for "medicinal plants" as an example.

JSTOR: Discipline: multidisciplinary, Access possibilities: free (fig. 5).

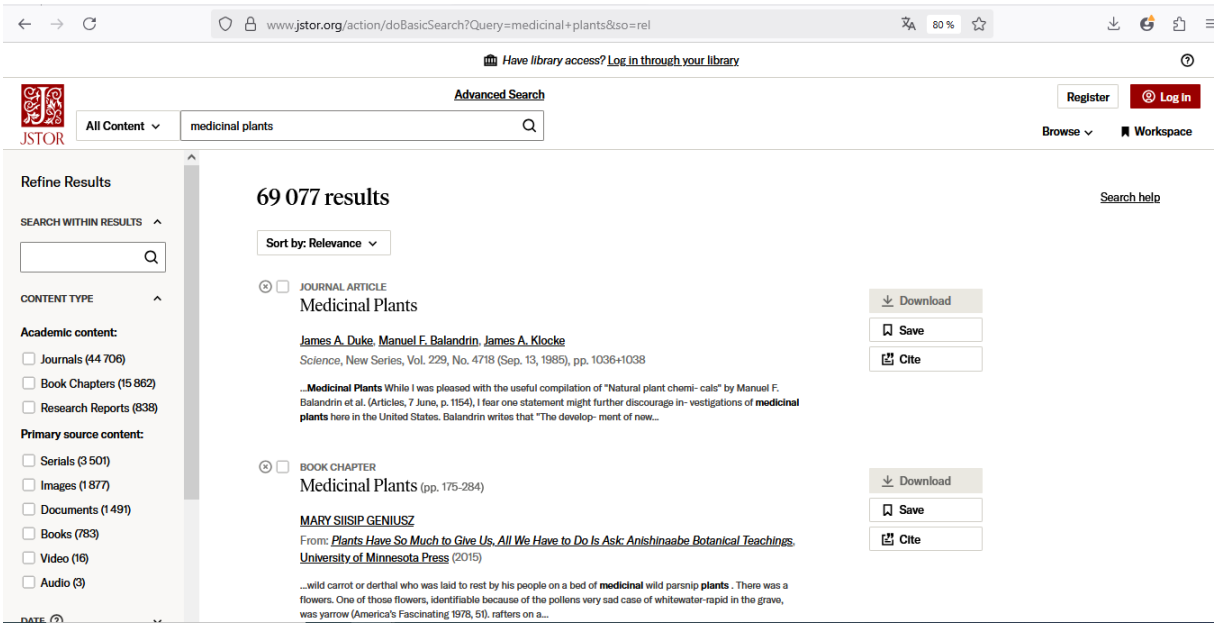


Figure 5:JSTOR search results page displaying articles on medicinal plants for example.

Tips for using bibliographic databases:

Keywords: The right search term is important. Think about what words an expert might use to describe the concepts you are researching.

Recent: Try to select articles written within the last ten years to ensure that you are not picking up outdated search results (fig. 6).

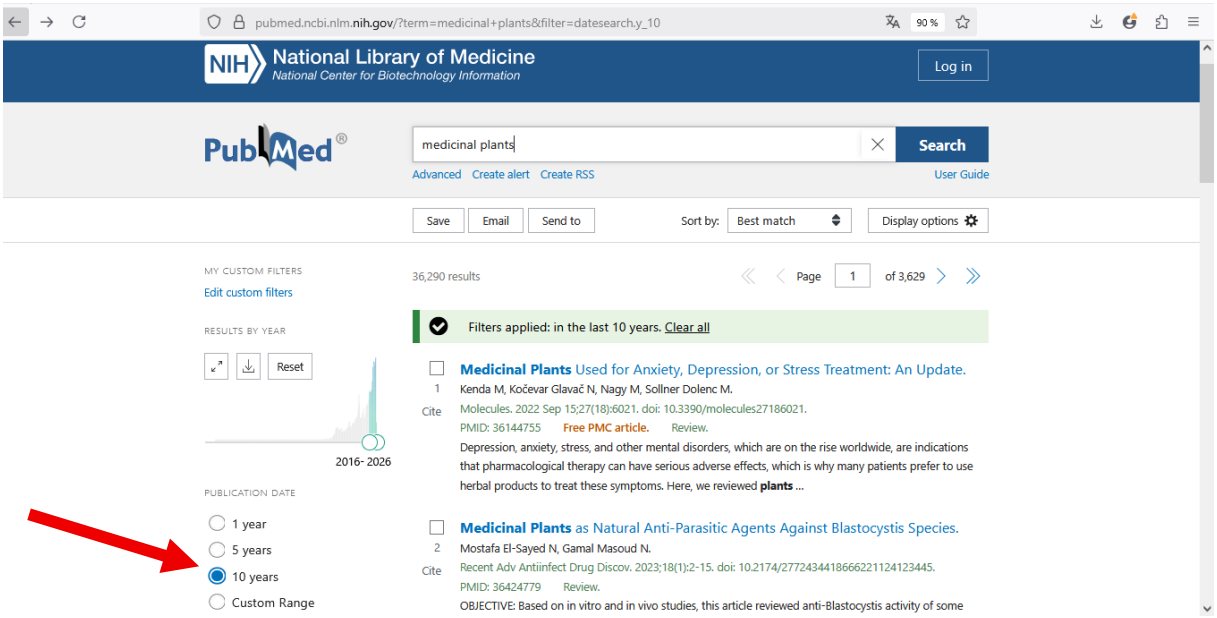


Figure 6: Selection of articles written within the last ten years.

3. Web resources

They are innumerable but their quality is extremely variable and the information is volatile. Some recommended sites for searching for scientific and academic information classified by category:

➢ **Specialized search engines**

● Google Scholar (http://scholar.google.fr/) (fig. 7)

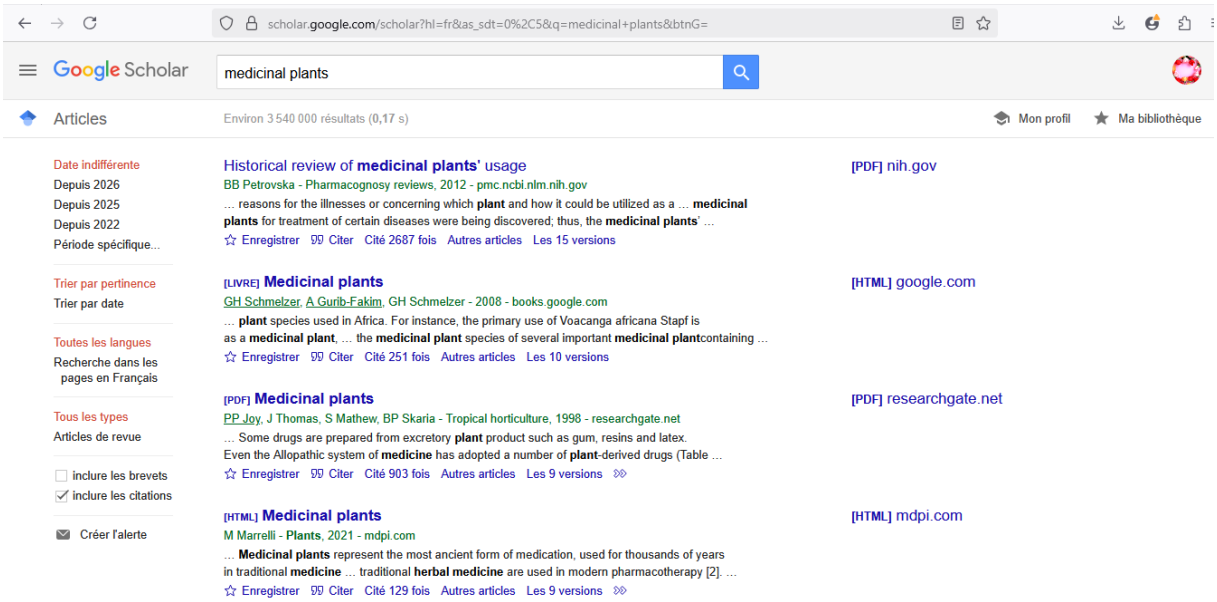


Figure 7: Google Scholar page.

● Google Books (http://books.google.fr/) (fig. 8)

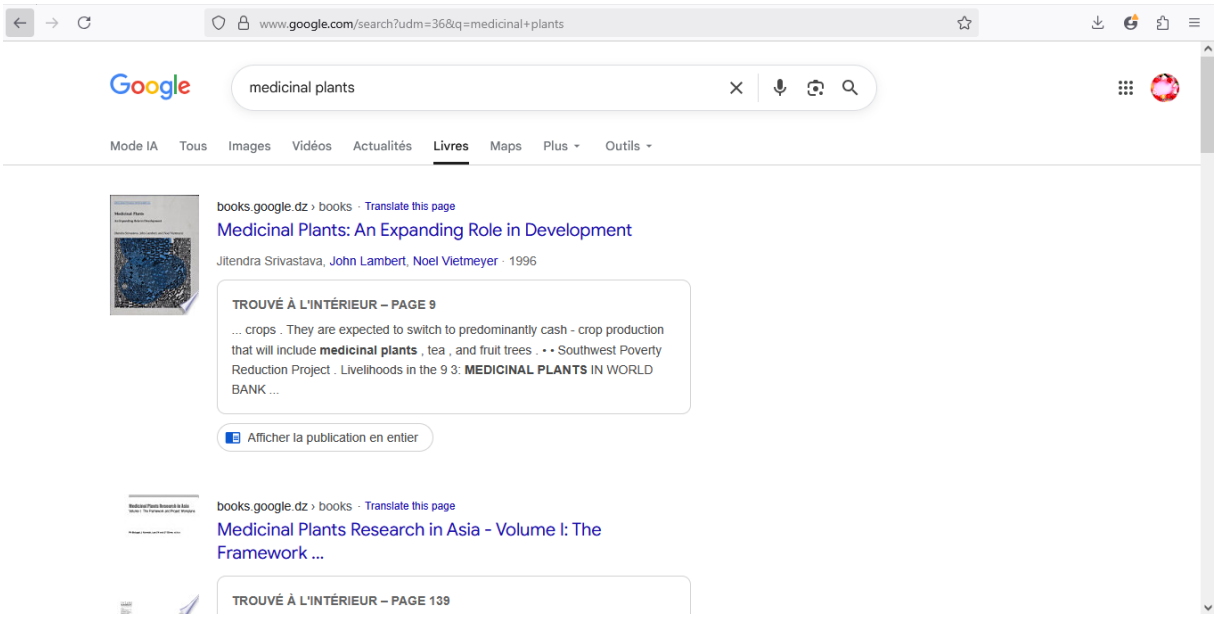


Figure 8: Google Book page.

- Theses.fr (http://www.theses.fr/) (fig. 9)

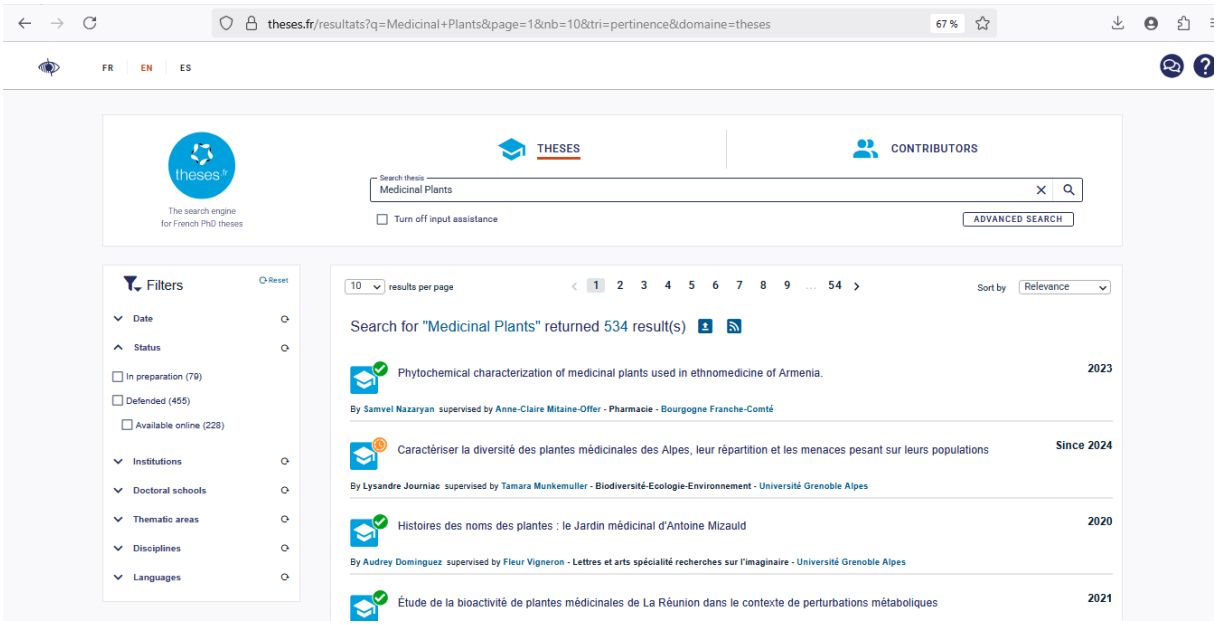


Figure 9: Theses.fr page.

➢ Scientific or thematic portals

- World Wide Science (http://worldwidescience.org)
- Online University (http://uel.unisciel.fr)
- Sciences.gouv.fr (http://www.science.gouv.fr/)
- International Center for Scientific Research (http://www.cirs.fr)

Step 3: Select the documents

Before using the information contained in a document, it is necessary to evaluate:

1) Reliability

-Does it aim to: Disseminate objective and verifiable information?

- Checks that the information is still up to date.

- How long has the document been published?

2) Relevance

Before reading the document, check that it corresponds to the subject's keywords by:

-Browsing the table of contents,

-Reading the introduction, conclusion and titles,

-Consulting the illustrations (which can be more telling than a long text),

-Eliminate documents that don't meet these criteria.

Once your documents have been selected, make a bibliography to cite your sources.

Step 4: Extract the information

From the documents you have selected, you must take notes, that is, select the most relevant information from the documents and leave the others aside. To do this, use a collection document.

A collection document is a working document, created with a text editor, which traces the progress of the research through the stacking of copy and paste extracts from the documents (fig. 10).

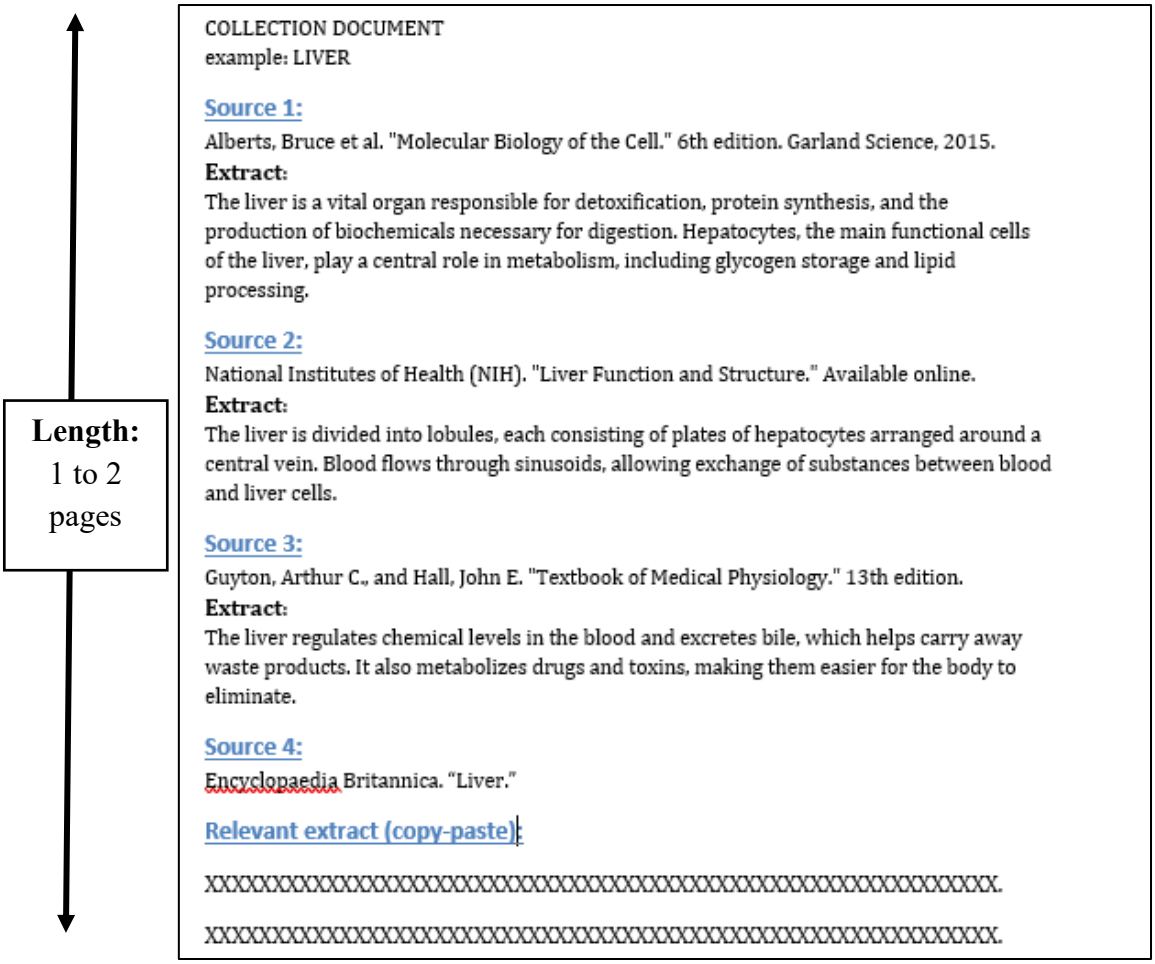


Figure 10: Example of a collection document.

Step 5: Process the information

1) From the printed collection document:

- Number the documents,
- Highlights essential information,
- Annotate the paragraphs: write in pencil in the margin the essential idea of each,
- Lists the themes of the subject addressed by each of the documents.

2) On a draft sheet, repeat the subject's initial questioning in a mental map and complete it with your new information.

3) Provide an update on the aspects of the topic that you would not have addressed. Repeat the previous steps if necessary.

4) Organize and classify themes and subthemes into a plan.

A plan:

- Must be coherent: each part and sub-parts correspond to a theme.
- Follows a progression: it responds to the problem.

5) Specify for each subpart on which document(s) you rely (document number).

Step 6: Format the information

1) Reread the instructions.

2) Carry out your work in accordance with the objectives of the type of production requested (presentation, report, dissertation, etc.).

3) To avoid being accused of plagiarism (theft of ideas), don't forget to:

- Use quotation marks when you use one or more sentences from a text,
- Cite your sources (via the bibliography and image captions).

4) Check spelling and grammar.

5) Reread your work to ensure that you have followed the instructions.

1.4 The key word

Keywords also referred to as descriptors when they are selected from a controlled vocabulary or thesaurus play a crucial role in bibliographic research. They enable the efficient retrieval of related publications from large databases by ensuring accurate indexing and classification. Inappropriate or poorly chosen search terms are among the most common sources of error in database searches. Because keywords determine how articles are cataloged and accessed, their selection directly affects the visibility and dissemination of a document. Inadequate classification may limit an article's reach and, in some cases, lead to it being overlooked entirely.

A keyword is a descriptor word or an expression which is chosen to represent a concept, most often a proper or common noun or a nominal group without an article which characterizes the content of a document or a searched subject.

1.5 Notions of noise and silence

In documentary research, two important notions are to remember. They reflect the failure of a request which must then be reformulated or refined.

1.5.1 Noise

It is the set of irrelevant documents found in response to a question, during a search for information. Relevant information is buried in the mass (fig. 11).

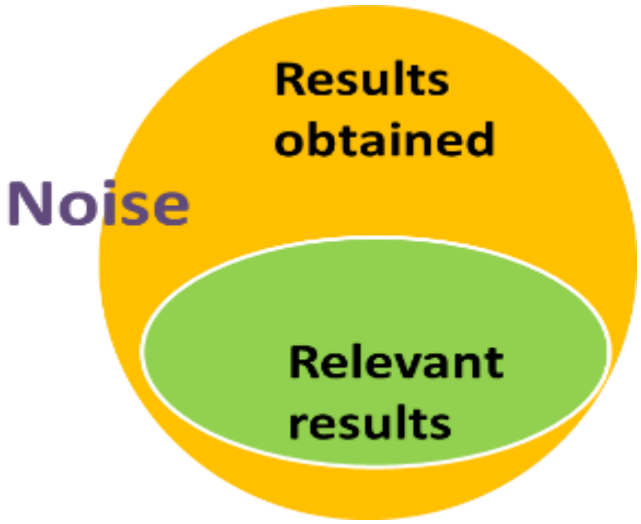


Figure 11: Diagram of "Noise" in documentary research.

1.5.2 Silence

This is the set of relevant documents not displayed during a documentary search. Relevant information is not found and the searcher may think that there is none (fig.12).

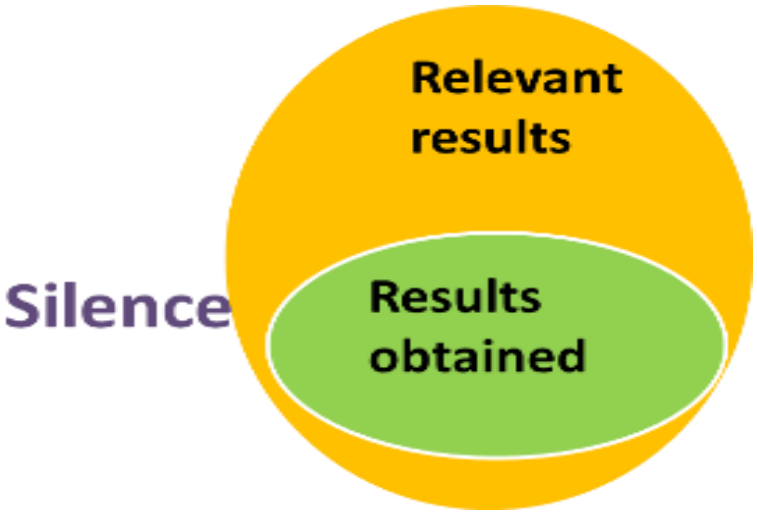


Figure 12: Diagram of "Silence" in documentary research.

1.6 Research techniques for effective research

The main problem of documentary research is often the loss of users' time in finding relevant information.

Search tools offer extensive and often underutilized possibilities for targeting searches.

The search possibilities offered are not identical from one search tool to another. The databases generally offer instructions that it is useful to consult quickly before starting to query in order to make the most of the search possibilities offered.

- Avoid stop words (Stop words are non-meaningful words such as articles, prepositions, pronouns and verbs, etc.) in search engines (type clear words like "medicinal plants").

- Use synonyms by referring to dictionaries of synonyms.
- Adapt your vocabulary to the databases, used (terms in English).

1.6.1 Search operators

- **Search by expression:**

The use of quotation marks " " allows you to search on a "character string". It is particularly useful when a search results in too many results or to search precisely for an expression.

- **Combine keywords**: **Boolean operators**

To search using more than one keyword, you must link them. This is the role of Boolean operators (named after their inventor, the English mathematician George Boole). These relationships are expressed by the words **AND**, **OR** and **NOT** (fig.13).

AND: is used to combine various keywords so that they simultaneously correspond to the subject of the search. For example, suppose you want to research “A” and “B”. By inserting the term “A” then the AND operator followed by the term “B”, the search tool will select all the texts necessarily containing these two terms. Very precise search.

OR: allows you to scan synonyms. One or the other of the terms must be found in the search results. By using the same example “A” and “B” linked by the OR operator, the search tool will group together all the texts including either the first term (A) or the second (B). Very broad search.

NOT: used to eliminate a term not relevant to the subject of the search. In this case, if you wish to carry out a search containing the term "A" without it being associated with the term “B”, the NOT operator will allow you to exclude the latter and the search tool will thus group together the documents dealing with of A without the term B being associated with it. The NOT operator therefore allows the exclusion of a term in order to refine the query. Directed research.

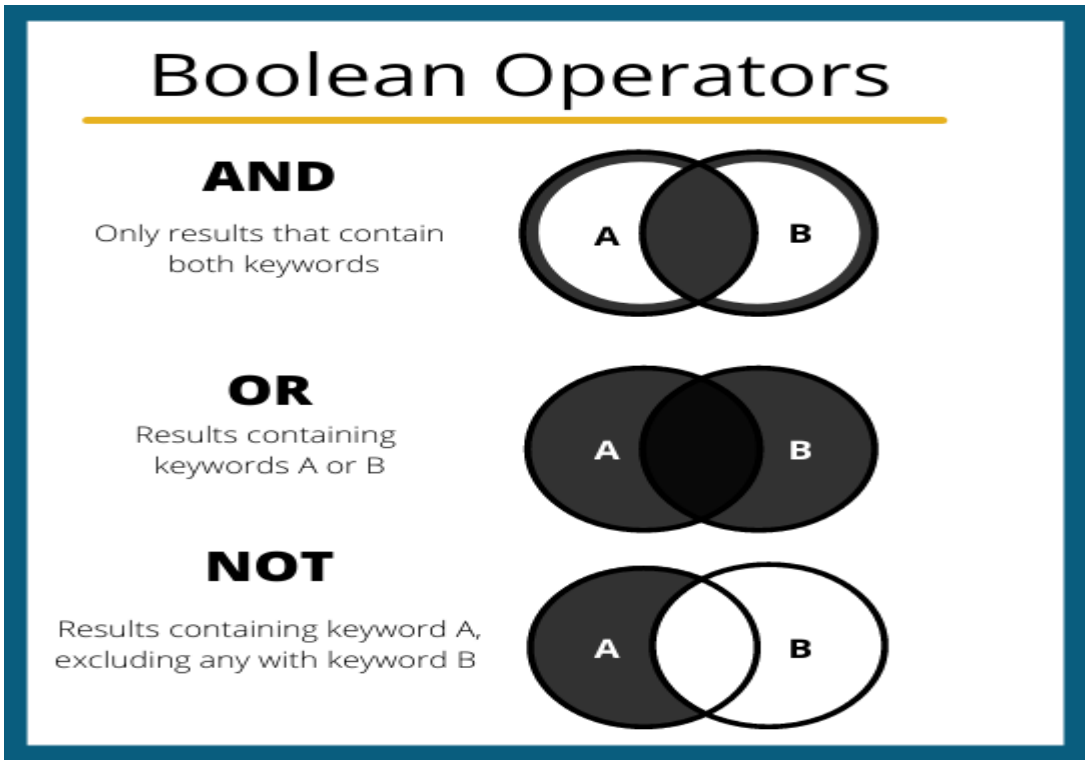


Figure 13: Boolean operators.

- **Truncation**

The characters **?** and ***** are signs indicating truncation (sometimes we find other signs such **!**). These signs allow you to replace one or more characters in the following way: By inserting for example: comm? the search tool will list all the documents which include the terms starting with “comm”, that is to say communication, commune, commercial, community etc.

2 Writing a scientific report

2.1 Definition of a scientific report

A scientific report is a document that describes the process, progress and/or results of technical or scientific research or the status of a technical or scientific research problem. It may also include recommendations and research conclusions.

A research report is a publication that reports the results of a research project or scientific observations on or about a subject.

A research report is a well-written document that describes the processes, data, and findings of a systematic investigation. It is an important document that serves as a first-hand account of the research process and is generally considered as an objective and accurate source of information.

2.2 General rules for writing a report

The written report is a reflection of the carried-out work, its purpose is to be read, and therefore it must be presented with the greatest care. To do this, he must respect a few rules:

• A good report should be **brief**.

It should contain all the necessary information and nothing more.

• Its **content** must be **promising**

The reader should find there all the information he is looking for on this subject.

• Its **structure** must be **adapted**.

Information should be easily found, reading a report should not be a puzzle, where its elements should be organized logically.

The cover page;

Acknowledgements (possibly);

The abstract;

The table of contents;

The introduction;

The body of the report “bibliographic part”;

Material and methods;

Results;

Discussion;

Conclusions;

The bibliography;

Annexes.

• Its **form** must **facilitate reading** (writing style and layout)

The discourse of a scientific report must be indirect and the formulations precise and exact (e.g. not "I carried out tests…", But "tests were carried out…" "I found the results…" But "the results obtained show…").

A research report should normally be written in the third person and avoid the use of pronouns such as "I", "Me", "My" ...

Sentences should be short and simple to make reading and understanding easier.

2.3 The three key elements of a scientific report

A reader in a hurry will often only read a few key chapters; if these pique their interest, they will then read the report further. These chapters are:

- The abstract
- The introduction
- The conclusion

For this, it is therefore necessary to invest a lot of care and attention in writing these chapters since the work is often judged according to these key chapters.

2.4 Types of scientific report

There are different types of scientific report:

- Practical work report,
- Internship report,
- Scientific article,
- Dissertation and thesis,
- Post seminars and conferences,
- Book….

2.4.1 Practical work report

The practical work report is a written work. As such,

• It must be written rigorously,

• It must be clear, precise and brief,

• It must allow someone who has never had the practical work to understand what you did and why you did it,

• The layout of the report must be airy, clean and attractive,

• Pay attention to the readability of the writing, the accuracy of the scientific terms and expressions used and the spelling,

• The questions asked in the statement of a practical work are there to guide the writing, and therefore their answers must appear in the report.

2.4.1.1 Structure of practical work report

a practical work report must be organized as follows:

1. **The cover page**

It must always be framed bearing:

- The student's first and last name and group.
- The date (must be written on the right at the top of the cover page).
- The number and title of the practical work must be noted in the middle of the cover page.
- A table of the note and the observation of the practical work must be drawn in the middle of the cover page.
- The work protocol (Goal, principle, handling) must be noted below the table.

2. **The sheets on which the practical work is done**

It must also be framed and made on white sheets without drawing on both sides; the drawings must be made only in black pencil. The drawings must be precise and faithful to the observation and must be centered, occupying the maximum space while reserving space for the legend, the latter must be noted correctly and without spelling errors and placed on the same side. Drawings must include titles and magnification.

- The practical work report must include the following parts:

a. Title of the practical work:

In general, this title is already present on the handout given by the teacher.

b. Objective(s) or goal of the practical work:

Write in a few words (one or two sentences) what you are going to look for in this practical work, the aim of the manipulations carried out.

c. Principle of the practical work:

Determine what the experiment or test of the practical work is based on.

d. Presentation of the manipulation:

You explain in a few lines (do not rewrite the text of the practical work sheet) the manipulation that you are going to carry out. Accompany it if necessary and when possible, with a small diagram.

e. Results or observations:

Give the observations, what happened, what you saw or measured (the size of the germinated seeds, the quantity of oxygen, and the color of the lime water... briefly, everything that changed compared to the initial state). The presentation of the results must be clear and unambiguous. It can be in the form of a table, a graph, a diagram or a short text. You have to find the form that seems most appropriate.

f. Interpretation of results:

This is the explanation of what was observed. It is necessary to connect previous course knowledge and the results in order to explain them well.

g. Conclusion:

It represents a summary of what we discovered in practical work. It brings together all the interpretations of your results (it is not a question of copying the entire previous paragraph, but of making a summary). It must therefore answer any questions that may be asked to help you.

2.4.2 Internship report

The internship is a key moment in the student's training. It concretizes a phase of practical learning of knowledge, know-how and attitudes in the field of development and solidarity at the national or international levels. It also provides an anchor point for developing a personal network of knowledge which will be essential in the search for a job later. Generally, the completed internship is accompanied by a report.

2.4.2.1 Definition of an internship report:

An internship report is a report (written document) which allows your evaluator to understand your missions and the structure in which you completed a training internship. This is about highlighting what you did and learned during your internship.

The internship report is a developed document which reports the activities and different tasks of the student within a company or an institution.

The objective of the internship is to acquire a first or new professional experience within the framework of a concrete situation. It also allows you to check the relevance of your personal

project while measuring your skills within the framework of an immersion linked to the field of training.

2.4.2.2 Objective of the internship report:

Its objective is to demonstrate that the internship is a professional path allowing the student to:

• Acquire in-depth knowledge of a given sector of activity.

• Better understand the functioning of a company, which of the reception structure in this case.

• Have practical knowledge, essential in the professional world.

• Understand the importance of the missions entrusted to him.

• Develop personal skills in addition to professional skills.

• Recognize and structure the learning achieved during this practical experience.

• Establish links between concrete facts observed in authentic situations and the theoretical notions covered throughout the training.

• Evaluate your strengths and weaknesses and identify areas for improvement.

2.4.2.3 Constituents of an internship report (structure)

To make an internship report plan, you must follow a certain structure (see fig. 14) and balance it well.



Figure 14:The internship report parts.

a. The cover page:

The cover page of an internship report contain:

- ✓ The name and logo of your educational establishment (university, etc.).
- ✓ The name and logo of the internship organization.
- ✓ The mention “Internship report”.
- ✓ Location and dates of the internship.
- ✓ Title of the report: Explicit and complete, the title must be “evocative” of your entire reflection; must correctly reflect the content and scope of the study presented while being clear and concise.
- ✓ First and last name of trainee.
- ✓ Name and last name of the internship supervisor.
- ✓ Year of study.

Why an internship report title is so important?

The role of an internship title is to inform the reader about the subjects that will be covered in the internship report.

- If a title is too short, it may leave certain information in the shade that may be essential.
- And if a title is too long, it risks becoming incomprehensible or even boring. It is therefore important to choose your words carefully to find the right balance.

The title of the internship report must therefore contain a few keywords to give clues about the content as well as the field of study. It is necessary to ensure that the key words are related to the chosen theme, knowing that the theme itself is based on the student's knowledge.

b. Acknowledgements (unpaginated)

All the people who contributed to the completion of the internship deserve a thank you from the student. Any significant assistance given during the work for scientific, physical or financial support from individuals or organizations must be acknowledged with appropriate thanks. It is preferable to only cite important personalities, both those within the training framework and those in the company who contributed to the smooth running of the company internship.

Thus, internship thanks can be addressed to:

• The internship tutor for the help and time he devoted to the student.

• People who transmitted essential information to the development of the internship, such as company staff for example.

• People who agreed to answer the questions asked during data collection.

c. Table of contents (unpaginated)

The table of contents which includes the internship report writing plan indicates the main parts and sections of the internship report. Due to **the pagination** characteristic of its presentation, it allows the reader to go directly to the pages that interest them. You must therefore choose the words to be concise and clear, and ensure that the structure of the document is logical.

Interest of table of contents of an internship report

Providing an overview of the plan of the internship report, the table of contents is a succinct and paginated list of the main titles and main sections covered in the development of the internship report. It offers the reader the possibility to find easily the pages which cover a given part. Thus, it is possible to navigate within the internship report, very practical for those who wish to go directly to one part or return to another.

d. Abbreviations list

If you have abbreviations, enter the meanings of the acronyms and organize the list alphabetically.

e. A list of figures, a list of tables

They must contain the numbers of the figures (or tables), their titles and their respective page numbers. This allows you to quickly find a figure or table.

f. Introduction

As its name suggests, the internship report introduction introduces the reader to the context of the internship. It must therefore contain a certain amount of key information which will encourage the reader to discover. The student must include two important aspects. The first step is to present the host company with its history, its development and its evolution, and the nature of its activity. Then, the student must mention the specific mission entrusted to him during the internship period. This part is the most important of the introduction; it is in the student's interest to pay particular attention to it. It serves to present the aim of the course. It can be summarized as:

- Presentation of the internship.
- Quick presentation of the company and its sector.
- Brief description of your missions.
- Problem of your report (if you have one).

- Announcement of the internship report plan.

g. Development:

This is the core of the internship report. The development must consist of three parts which are:

First part: Presentation of the internship environment

It is devoted to the description of the host structure: the presentation of the host company or organization, as well as the contextual sector of activity. This is a personal presentation based on internal company documents. To this end, the following points will be addressed:

▪ Status of the host structure (public, private/commercial, associative/cultural, educational, administrative, etc.).

▪ Geographic location.

▪ Company identity card (history): date of creation, professional sector, contact details of the manager (surname, first name, address, telephone, email address, turnover, etc.).

▪ Objectives (specifications, programs, results report, etc.).

▪ Organizational structure (organization chart, responsibilities, teams, type of work, etc.).

▪ Competition (organizations that offer the same services, differentiation strategies, common points and specificities, etc.).

Second part: Description and analysis of the mission

This part is devoted to the description of the mission which you carried out.

1 Working situation and working conditions: what is the context of the position?

The following points will be developed

- The job title.
- Job position within the company and department: you will situate the position in relation to the general organization chart of the company and, if necessary, of the department (in this case describe this department precisely, its place within the company, its specific missions, its employees).
- The role of the student (functions held) in the organization: You will explain what your place and your mission were on the scale of the structure and its overall project: your particular function within the service, as well as the main aspects strategies relating to the missions carried out and the specificities of the position (equipment, team management, travel, various on-call obligations, etc.).

2 Missions: why this position?

You will describe what the company expected from you (results, deadlines, etc.).

What should you do? Why, for whom? How long?

Description of the mission(s)

3. Activities: what is the nature of this position?

This is the most important subsection.

The description of the activities concerns what was carried out and the means which made it possible to accomplish the missions described above. What have you done? And how? (With what means?).

For each activity, you will specify:

What you have done? What type of result(s) did you want to achieve? What goal(s) were you pursuing? What were the problem(s) to be solved? What was your project?

▪ What was your degree of responsibility?

How was your activity important to the company? What consequence(s) could be incurred in the event of a problem? Who accompanied you? Who did you collaborate with?

▪ What problems did you encounter? How did you get them?

What solutions were found?

What devices? What were the different stages? How did the action unfold? What means were used to achieve your goals?

▪ What were the results in the end?

4. Supervision of the internship: what professional tutoring?

This sub-section is devoted to the description of the internship supervision methods. (The coaching and supervision received in the company).

During the internship, did you feel like a full-fledged actor, assistant, observer, etc.?

Who were with you in contact in your work within your structure? On what activities or projects? What nature was this working relationship (negotiation, collaboration, information, advice, control, etc.)?

Generally speaking, how would you describe your relationship with your internship tutor?

Third part: professional skills acquired

In this part, the student puts:

-Description of new learning

-What link do you establish between your internship experience and the lessons acquired at the University?

-What impact did this experience have on the representation you had of the professional field, the profession, professional practices, and the company?

-What impact does this experience have on your professional project?

-Lessons learned from this experience for the future?

h. A conclusion

- Give your general opinion on the position, the missions and the company.
- Answer the question (if you have one in your introduction).
- Try to provide an interesting opening on your work.

A few questions can support the development of this conclusion:

Did the internship surprise you, disappoint or reinforce your professional project?

On what aspects do you need to question yourself, continue your training, specialize, etc.??

What is your vision of the profession?

What types of skills need to be developed?

- You will also address the relationships between your training (personal and academic) and your internship experience.

i. The bibliography

It contains detailed references that helped you to write the report, in alphabetical order (author, title, year, edition, etc.). There is no mandatory standard for the presentation of the bibliography, but the same form should always be maintained.

Ex: Qazan WS 2008. Effects of short- and long-term treatment of Ballota undulate on female albino rats fertility and pregnancy. Pak . J. Biol . Sci ., 11 (4): 638-642.

j. Annexes

These are documents that allow you to deepen your work: documents presenting the company, programming lines, diagrams, etc. The attached documents must therefore be closely linked to the text of the report (this is not a question of accumulating data in an unjustified manner). All attached documents must enable a good understanding of your demonstration.

2.4.2.4 Layout

Here are the basic rules to follow:

- The length of the report must be between 15 and 30 pages maximum, excluding annexes.
- Margins of 2.5 cm (top, bottom, and right).

- The desired standard font is Arial or Times.
- Font size must be 12.
- Choose a simple spacing of 1.5.
- Justify the paragraphs.
- Write only on the front.
- Footnotes must be 10 inches in size and line spacing 1.
- Use white A4 paper.
- Don't forget to number the pages.
- Don’t forget to number the annexes.

2.4.3 Scientific article

A scientific article is a document written by scientists to communicate the results of a study or scientific work. There are different types:

a. Original research article

This article reports the results of a scientific study. Articles of this type are published in scientific journals, also called refereed journals or peer-reviewed journals, which are essentially collections of scientific articles published every few weeks or months.

b. Review article

This article presents, summarizes, and analyzes the current state of knowledge on a given subject, usually a fairly limited subject. Articles of this type are published in scientific journals which specialize in this type of article, or in the same journals which also publish original research articles.

c. Comment

This article is generally short, and consists of a review of another article already published. It is usually published in the same journal that published the article that is being criticized.

d. Book chapter

Like a review article, but published as a chapter in a book which brings together a set of such synthesis/chapters, on different subjects but still all linked to the same general theme.

e. Technical report

It is very similar to an original research article; it reports the results of a study which was commissioned by a ministry or a company for a very specific purpose, often with a view to

possible practical application. It is published individually (rather than in a journal bringing together several articles) and in rather limited numbers, either by the ministry which commissioned the study or by the company which wants to uses it for internal distribution.

2.4.3.1 Original research article

2.4.3.1.1 Structure of an original research article

There is a standard, preferred way to write an original research paper. For format, we follow the **IMRAD** structure. The acronym, IMRAD, stands for Introduction, Methods, Results And Discussion (see table 1).

Table 1: Structure of original research article.

Before	**Body of article**	**After**
Title	**I**ntroduction	bibliographical references
Authors	**M**aterials and methods	
Affiliations	**R**esults… **A**nd	
Abstract	**D**iscussion	
Keywords	Conclusion	

The article consists of the following elements:

a. Title:

The title should be as short and concise as possible while accurately reflecting the content of the article. It can be considered a brief summary of the abstract. An effective title should be concise, accurate, clear, complete, informative, and attractive.

In general, the author writes the title last, because he then has a synthesis of his work in mind. The title of an article is the equivalent of an advertising trailer. A good title means that the article will have a better chance of being read more. This explains that the important words must be first and that it must be quite short.

Look at the titles of articles already published in scientific journals to get an idea of how to compose a title.

b. Authors' names and institutional affiliations:

It is essential to indicate the full names of all authors and co-authors who contributed to the preparation of the article, as well as their institutional affiliations. The formatting and presentation of this information must strictly follow the guidelines provided by the journal in which the article is intended to be published (Instructions for Authors).

c. Abstract:

You will have to construct a structured abstract: it generally includes goal, material and methods, results, discussion and possibly conclusion. It must be informative, i.e. understand the gist of the article. You must therefore identify in your reading and the answers to the questions the key words and sentences that you will have to integrate.

Its length maximum is 250 words (each word counts). Summarize all sections of the article: 1-2 sentences for the Introduction, 1-2 sentences for Materials and Methods, 1-2 sentences for Results, and 1-2 for the Discussion.

Keywords: are significant words (or word-combinations consisting of more than one word) from a paper or document used as an index to the contents. When listed in databases, they help to provide efficient indexing, search and retrieval mechanisms thus enabling the reader to quickly find texts on the topic of interest. Keywords are usually placed after the abstract before the main body of a text. The number of key words to be provided is in most cases determined by particular editorial requirements.

Add relevant keywords not included in the article title and abstract: be specific.

d. Introduction:

The introduction should do three things:

(1) Present the overall framework of the subject, the knowledge already acquired on the subject;

(2) jump from the global framework to the specific framework and state the problem under study, or state the question posed;

(3) mention the interest in answering this question. Tips to arouse interest: "This variable has never been studied under such or such circumstances" or "This question has never been studied with this species, which nevertheless has the following economic interest" or "Based on the reasoning above, we would make the following prediction" or "To test this new hypothesis, we studied such and such a system/species/population".

e. Material and methods:

Describe, in complete sentences and paragraphs, how the experiment(s) were carried out (recipes in the form of point-by-point lists, as in some laboratory reports, are prohibited).

Tip: follow more or less the chronological order in which the experiment was done. Another tip: make sure all-important variables are mentioned, defined, and that you describe how you measured them.

Last tip: Give enough detail that if another scientist read this section, he or she could repeat your experiment and get results similar to yours.

f. Results:

Write a text that describes the broad outlines of the results obtained. Refer to figures or tables to explain the results in more detail, but still state the general trends that emerge from each figure or table.

Warning again: don't start interpreting your results here, save that for the discussion section that follows.

And above all: do not present a table and a figure that show the same data. Choose one or the other of these two ways of presenting the results, but not both at the same time.

Generally, this part contains tables, diagrams, to make reading and interpretation clearer and easier.

g. Discussion:

Its construction must enable it to meet several objectives:

The first objective is to answer the question asked. A short introduction (1 or 2 sentences on the parameter studied.

The second objective is to judge the quality of the work and the validity of the results. They must make it possible to propose a conclusion justified by these results.

The third objective is to compare the results obtained with those in the literature.

The discussion definitely requires intellectual effort on the part of the author. Read books or scientific articles to get ideas that might explain their results.

Some journals favor grouping results and discussions into a single chapter.

h. Conclusion:

The conclusion follows logically from the two preceding sections. Rather than repeating the results, it synthesizes them within a coherent and easily understandable framework. The

conclusion should be concise, clear, and precise, and it must present the final statement that logically emerges from the results of the study.

i. References (Literature cited):

List all the references you cited in the text, according to the citation rules required by the journal where the article is published. Do not list works or articles that are not cited in the text, even if you consulted them during your work.

2.4.3.2 Review article

Writing review articles is a useful skill to develop early on in your career as a scientist, whether pursuing an academic career path or not. In any field of science, it's important to read widely to keep up to date with the latest developments, and writing a review article encourages you to critically evaluate the strengths and weaknesses of the literature to extract the most pertinent information.

2.4.3.2.1 How to write a review article?

Writing a review article begins with:

- selecting a relevant and interesting topic that has not been reviewed recently.
- Appropriate keywords must then be carefully chosen to guide an effective literature search and to help structure the review.
- The next step involves collecting and critically reading original research articles using reliable sources such as Google Scholar, while balancing classic and recent studies. A good review does more than summarize published findings; it provides a critical, unbiased analysis that evaluates the quality of evidence, highlights inconsistencies, and identifies research gaps and future directions.
- Although the structure and depth depend on the type of review, the main goal is to critically appraise existing knowledge.
- Finally, conclusions may range from a simple summary to a deeper interpretation that reveals new patterns or insights, ensuring the review is thoughtful and rigorous.

2.4.3.2.2 Structure of a review article

Writing a review article requires not only subject expertise but also a well-structured organization. A standard review article should include essential sections such as the title, authors and affiliations, abstract, keywords, introduction, main body with appropriate headings, discussion, conclusion, competing interests, and references. The structure and headings of the

main body depend on the scope and type of the review, and each section should present the author's critical insight aligned with the article's objectives.

For systematic reviews, additional sections like **"Review Criteria"** and **"Analysis"** may be included. Although some guidelines suggest using research-specific headings such as "Methods" and "Results," these are discouraged in review articles to clearly distinguish them from original research. Authors should avoid using research-specific terms (e.g., "this research") and headings like "Literature Review" or "Related Works," since the entire article is based on literature review. Maintaining a clear distinction between original research and review articles is essential, and appropriate review-specific headings should be used instead.

a. Title:

The title should succinctly describe the scope of the review in a clear, accessible and engaging way. it should be a single, standalone sentence that might be separated into two parts with a colon or hyphen. Each word must be deliberately selected to maximize informational value and improve visibility in online search engines. Abbreviations should be avoided in titles unless they are very common and don't need defining e.g. DNA. (7–12 words)

b. Abstract:

The abstract briefly outlines the background of the topic and highlights what makes it timely and worth reviewing, and summarises the specific goals or key messages of the review. The Abstract of a review article is typically structured as a single paragraph which may include the research question or rationale, the primary studies analysed, and the resultant conclusions drawn from those analyses.

The abstract is generally written last and doesn't include references. Abbreviations and heavy jargon should be kept to a minimum, but do include keywords that will optimise searchability. (150–200 words).

c. Introduction

The introduction provides more detailed background/contextual information to introduce the topic, including a basic description of key themes, terms and processes that will aid understanding of the rest of the article.

It should also define the aims and scope of the article and briefly outline which subtopics will be discussed. This section should be written as continuous prose and should be supported with references, and figures (or other display items) if appropriate. Specific research findings would not usually be discussed in significant depth in the Introduction. (300–500 words).

d. Main text

The central part of the review, which is usually divided into several subsections with appropriate topic-specific headings, should provide a detailed discussion of research findings relevant to the overall topic, with an adequate description of the methodologies, results and conclusions of individual research papers. Related research papers should be discussed together/under the same subheading, and these links should be made clear to readers to form a coherent narrative. Throughout, the significance of research findings in the broader context of the research topic being reviewed should be highlighted, and the author should aim to critically appraise the strengths and weaknesses of individual papers rather than just laying out facts. All subsections should be independently introduced and concluded, and the text should be fully supported with references. Care should be taken to cite the original article reporting a specific finding and the overall discussion should be balanced. Figures, tables and other display items should be used to aid understanding and break up long sections of text. (3500–5000 words)

e. Conclusions

The conclusion rounds up the article by providing a summary of central themes and take-home messages. Can also provide the author's perspectives on future research in the field, key challenges and outstanding questions. Usually written as continuous prose but a bulleted list could be used to emphasise key points. Supporting references might be included. (350–500 words).

f. Organizing references

When collecting and analysing research articles on a chosen topic, it is essential to systematically track all sources. Authors should carefully select the most relevant studies and maintain accurate bibliographic records for later use. Because literature searches often generate a large volume of information, effective organization is crucial to ensure consistent and correct citation. To support this process, many researchers rely on citation management software to store references, insert citations, and generate bibliographies. Tools such as EndNote, Evernote, RefWorks, Papers, Zotero, and Mendeley are commonly used, although not all are freely available. Among free and user-friendly options, Mendeley and Zotero are particularly popular, while ZoteroBib offers a simple online solution for quickly creating formatted bibliographies without using a full reference manager.

Authors should cite only the most relevant references, avoid excessive in-text citations within a single sentence, and ensure that each citation accurately supports the associated claims. According to the *Extensive Reviews* journal guidelines, citations should not exceed 25

references per 1,000 words, with a maximum of 300 references per review article; at least 50% of these references must be from the previous two years. To minimize bias, self-citation is limited to less than 20% of total references, including citations of work by the same author, collaborators, the same laboratory, or the same journal.

2.4.3.2.3 Where to publish?

Although some journals do not accept literature reviews because they prioritize primary or empirical research, many others actively encourage the submission of review articles due to their higher citation potential, particularly when they synthesize research across multiple levels. In general, review articles that are rigorous, well-structured, and methodologically sound have a greater likelihood of acceptance. An effective approach to identifying suitable journals is to first define target journals and carefully examine their stated aims and scope, which usually indicate preferred article types. Reviewing recent issues is also essential to confirm whether the journal regularly publishes review articles. In addition, several journal-selection tools—such as Edanz Journal Selector, Elsevier Journal Matcher, IEEE Publication Recommender, Journal/Author Name Estimator (JANE), Journal Rater from PhD Voice, Scholarly Publishing Information Hub (SPI-Hub), Springer Nature Journal Suggester, and Wiley Journal Finder—can assist authors in identifying appropriate journals for submission.

2.4.3.3 Scientific use of tenses

Good scientific prose uses a precise vocabulary. Scientific prose also uses verb tenses in a standardized way. When discussing research, the present tense indicates general knowledge and general principles, while the past tense indicates results of experiments.

- **Present tense is for generalities**

Use the present tense for general knowledge statements, widely accepted statements, and statements for which you could cite textbook references; for example:

• “Black-eyed Susan (Rudbeckia hirta), a member of the Aster family, is a plant native to North America.”

• “Hexoses formed by digestion in the intestinal tract are absorbed through the gut wall and reach the various tissues through the blood circulation.”

• “The term ‘nuclide’ indicates a species of atom having a specified number of protons and neutrons in its nucleus.”

• “On a protein-rich diet, the amount of methyl histidine in the urine increases.”

Past tense is for specific observations

Your results the particular observations that you made during a research study are bits of history, so use the past tense when you report your experimental results. For example:

• Then rats were allocated in 8 groups randomly (8 in each group).

• Duration of experiments was four weeks and water and food intake measured daily.

• Data are presented as mean ± SD. Statistical analysis was done by SPSS software version 17.

• The data showed that diabetes induction causes a significant increase in glucose, triglyceride, total cholesterol, and…etc.

➢ An important word about plagiarism

Plagiarism consists of copying or translating, more or less literally, one or more sentences from an already published text without indicating that this is what one has done, thus suggesting that the sentence or sentences are our own creation. Plagiarism is extremely wrong.

One trick to avoid plagiarism is to compose your text without having other works open in front of you; use your own words.

2.4.3.4 Formatting of the scientific article

Adapt the form of your article to the requirements of the journal (see the instructions for authors or the "Aims and Scope" section of the journal presentation). And put yourself in the shoes of a referee.

2.4.3.5 Importance of publishing a scientific article

It is necessary for:

- Have the interest of your work and its scientific quality validated,
- Disseminate the results of your research,
- Archive scientific knowledge,
- Be evaluated by your supervisory authorities,
- Be known and recognized by your peers,

In all cases, you must identify the journal in which you want to publish: at the start of your draft article, before writing, and identify an alternative journal to which you will submit your article in the event of refusal.

2.4.3.6 General information on scientific journals

Scientific journals allow researchers in the same discipline as the author to read research results.

Scientific journals are organized into volumes.

A volume can contain several issues depending on the publication frequency of the journal.

Issues are often themed and can be special.

A limited number of articles or pages (specified size).

There are 3 classes of scientific journals, which are:

1. A-rank journals

- International journals with innovative themes.
- Updated literature review.
- Rigorous research plan and methodology.
- Difficult and long evaluation and revision process.
- Minimum two referees per manuscript, rejection (80%).
- International distribution (language).
- Recognized by the scientific community.
- Presence in academic libraries.
- Publication of fundamental research articles.
- Strong contribution to the development of the discipline.

2. B-rank journals

- Demanding international journals.
- The evaluation process faster than for A.
- Lower rejection rate.
- International distribution.
- They are more open to critical analyzes and reflections, to empirical replication. - Classic themes and exploratory research.

3. C-rank journals

- Easier access journals for non-scientists.
- Less rigorous selection criteria and process.
- Magazines intended for sectors of activity or limited geographical areas.
- Journals with less international presence and less academic recognition.
- Dissemination of descriptive studies, technical studies.
- Frequent participation of non-academic authors.

ISSN referencing

•The ISSN (International Standard Serial Number) is an eight-digit number that identifies periodicals, including continuous electronic resources.

•The ISSN is a numerical code which serves as an identifier: it has no intrinsic meaning and does not in itself contain any information relating to the origin or content of the publication (Fig. 15).

DOIs and URLs

The DOI or URL is the final component of a reference list entry. Because so much scholarship is available and/or retrieved online, most reference list entries end with either a DOI or a URL.

- A **DOI** is a unique alphanumeric string that identifies content and provides a persistent link to its location on the internet. DOIs can be found in database records and the reference lists of published works.

Example: Smith, J. A., & Brown, L. K. (2020). Effects of temperature on enzyme activity in bacteria. *Journal of Experimental Biology, 223*(4), 112–120. https://doi.org/10.1234/jeb.2020.56789

- A **URL** specifies the location of digital information on the internet and can be found in the address bar of your internet browser. URLs in references should link directly to the cited work when possible.

Example: Raven, P. H., & Johnson, G. B. (2023). Photosynthesis and energy conversion in plants. *Encyclopedia of Life Sciences*. Retrieved January 15, 2026, from https://www.els.net/photosynthesis-and-energy-conversion



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Original Research Article

Acute and Subchronic Toxicity Study of Methanol Extract of the Aerial Parts of *Ruta montana* L. on Adult Female Wistar Rats

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ABSTRACT

Ruta montana L. locally known as fidjel belongs to the rutaceae family. This plant is used in traditional medicine as an aphrodisiac, abortive and as hypoglycemic. The aim of this research is to evaluate the mean lethal dose (LD_{50}) and subchronic toxicity of methanol extract of *Ruta montana* L. on female rat. To determine the LD_{50}, 30 female rats were divided into 5 groups; each group received intraperitoneally, a single dose (800, 1000, 1200, 1400 and 1600 mg/kg bw) of the extract, toxicity symptoms and mortality were registered for 14 consecutive days. In subchronic toxicity (45 days), 14 female rats were divided into 2 groups; treated group received intraperitoneally 58,7149 mg/kg bw = 1/30 LD_{50} of the extract and control group received physiological water. Body weight, relative organ masses, reproductive hormones, haematological, biochemical and histopathological parameters were evaluated. The LD_{50} value was calculated to be 1161.4486 mg/kg by Litchfield and Wilcoxon method. In the subchronic study, there was a significant reduction in body weight in the 2nd and 7th week ($P<0.05$). Relative mass of the brain and ovaries registered a significant decrease and increase, respectively ($P<0.05$). Follicle stimulating hormone (FSH), luteinizing hormone (LH) and biochemical parameters did not record significant difference. Haematological parameters presented significant increase and decrease in mean corpuscular haemoglobin (MCH) and red cell distribution width (RDW), respectively ($P<0.05$). The histopathology revealed no abnormalities in different studied tissues. The current study revealed that the methanol extract of *Ruta montana* at the tested dose had no toxic effect on subjected organs.

Keywords: *Ruta montana* L., Female rats, LD_{50}, Subchronic toxicity, Reproductive hormone.

Introduction

Medicinal plants are used for centuries as medications for human illnesses including fertility problems,[1] due to the therapeutic value of their constituents,[2] without the actual knowledge of their toxic potential. Among the problems of the medication by plants, are the imprecise prescribed doses, frequently resulted in overdose.[3]
Medicinal plants are used by more than 80% of people in the word (according to the WHO) for their health problems, where the traditional use, the natural source and the economic side are some reasons for this worldwide utilization.[4] Among these plants we find *Ruta montana* L. *Ruta montana* L. (Rutaceae) is a plant of 20-40 cm,[5] originating in Europe, particularly the mediterranean area, but it is widely distributed in all the moderate and tropical areas.[6]
Ruta montana L. locally known as fidjel,[7] contains many compounds belonging to different chemical classes such as alkaloids, coumarins, flavonoids, essential oils, saponins, triterpenes, phenols and lignans.[8] The richness of this plant by these compounds probably a reason for its large use in traditional medicine.[9] This plant is not used almost any more in Europe; on the other hand it remains a plant appreciated by the tradipraticians in particular in the mediterranean basin and in South America,[10]

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Citation: Nadra G, Nadia M, El-Ouahab BA. Acute and Subchronic Toxicity Study of Methanol Extract of the Aerial Parts of *Ruta montana* L. on Adult Female Wistar Rats. Trop J Nat Prod Res. 2022; 6(8):1203-1209.

where it is used as an emmenagogue, an aphrodisiac, abortive,[10-12] also as an antihelmintic,[10] hypoglycemic,[13] antiherpetic,[11,13] antipyretic,[14] in the treatment of hepatic diseases,[15] hypertension, [16] and vitiligo.[17]
To our knowledge, no scientific investigations concerning the toxicological studies of *Ruta montana* L. on female rats (albinos wistar) such as the determination of the LD_{50} value and the subchronic study. The purpose of this study is to determine the LD_{50} value and the subchronic toxicity study of the methanol extract of the aerial parts of *R. montana* L. on adult albino wistar female rats.

Materials and Methods

Plant materials
The fresh aerial parts of *R. montana* L. was collected in June 2020 from Beni Aziz, a place at North East of Setif (Algeria). Taxonomic identification was done by Dr. Nouasra W. (Department of Plant Biology and Ecology, Faculty of Nature and Life Sciences, Setif 1 University, Algeria) (Figure 1). The specimen with voucher number USBS 6-20 was deposited in the department of plant biology and ecology of the same Faculty.
The aerial parts were dried at room temperature in shade for fifteen days; it was manually purified from stems and all impurities and stored in paper bags in the refrigerator at - 4 °C until use.

Plant extraction
Leaves, flowers and fruits of *R. montana* L. was powdered using an electric grinder, the powder (100 g) was macerated with 500 mL of methanol (90%) at room temperature for a week, where the mixture was daily agitated for one hour. The filtrate was evaporated at 37°C at

Figure 15: Example of ISSN referencing.

2.4.4 The dissertation (thesis)

Whatever the training course, the end of schooling is crowned by a dissertation, the objectives of which can be diverse.

2.4.4.1 Definition

The end-of-study dissertation, applied research dissertation or thesis (the terminology varies depending on the program) is a written document presented according to rules that differ depending on the cycle and is generally the subject of an oral presentation before a jury composed of teachers.

2.4.4.2 Structure of a dissertation

The format of the dissertation and the structure of the document are likely to vary greatly depending on the institutions and types of dissertations considered, but several common

characteristics can be highlighted. The dissertation generally has between 60 and 90 pages (excluding cover page, abstract, acknowledgements, bibliography and appendices). The following components are commonly found in order:

- **The cover**

The cover (printed on a rigid cardboard support) generally includes the following information from top to bottom:

- University logo and name;
- First and last name of the student;
- Name of the document and the training course; for example, “Doctorate thesis”;
- Title of the dissertation;
- Date of submission;
- Name of the dissertation director and jury members;
- Promotion or year of study.

- **A cover page**

It is the resumption of the cover, printed on paper.

- **Acknowledgements**

It is left to the discretion of the student, for the help received either from their teachers, tutors, colleagues, etc. On the other hand, it is always regrettable to don’t cited people who helped the candidate in their search for information, in their data collection, in the processing of data or the writing... etc.

- **Dedications**

The student can, on a page, mention the people to whom he dedicates his work.

- **Abstract (French, English and Arabic) and key words**

It is a single, well-developed paragraph of approximately 250 words. The function of the abstract is to briefly describe all parts of the dissertation; it highlights key content areas, the purpose of your research, the importance of your work, and key findings. The abstract should be the last thing you write. Add relevant and specific keywords.

- **Abbreviations list**

This list must be presented in alphabetical order. The meaning of abbreviations, acronyms and logos, already indicated in the text when first used, is recalled here.

- **Table of contents**

This is the list of parts, chapters or major subdivisions of the dissertation. The summary gives an overall idea of the work plan (It allows you to quickly find a title).

- **Lists of tables and figures**

Numbered lists of figures (diagrams, graphs or illustrations) and tables, accompanied by their pagination. Thanks to these lists, the reader can find their way more easily when looking for a document that has already been read.

- **Introduction**

The introduction sets the framework for the work and also presents the plan adopted. Its style should be simple and clear. The ideal is that it arouses the reader's interest and makes them want to read the entire document. The introduction usually includes the following:

- The importance of the subject: it is appropriate to underline the interest of the subject you are dealing with;
- The topicality of the subject: the subject of the dissertation generally has a link with current events that it is recommended to recall to justify the interest you have in it;
- The different aspects of the subject: a subject always has several dimensions. It is appropriate to clarify the different facets of the subject.
- The definition of terms or concepts essential to understanding the title and subject.
- The objective of the dissertation: this is the purpose of your work.

- **Development (bibliographic part, materials and method, results, discussion)**
  - **Bibliographic part:**

The bibliographic synthesis is the summary of the most important works that have been carried out in the field. Its main function is to situate the work done in the dissertation in relation to other work in the field. The works that must be chosen by the student to be mentioned in the bibliographic summary must either:

- Be in the theory of the subject and support the idea of the dissertation.
- Be directly related to the theme.
- Put the dissertation in a current context.
- Define current research in the field.

➢ **Materials and methods:**

This part must be able to answer the question HOW? How do you plan to verify your hypothesis? You must explain in detail how you conducted your study. The chronological order of the experiment must be respected.

- Equipment; it is necessary to cite the list of measuring tools used, the devices used and their technical characteristics in detail, as well as the reagents and products used with their references.

- The experimental protocol; it is necessary to describe the progress of the stages of carrying out the experiment with the dates and places and the photos as precisely as possible.

- Data analysis; describe the method for processing the results: statistical processing, there are several software for processing the results such as: Sigma Stat, Graph Pad, Excel…etc.

➢ **Results:**

The results are the culmination of the research and the basis of the discussion. Only observed facts should be reported, not results unrelated to the subject. There should be no comments or references.

The results can be presented in the form of: simple tables, figures, diagrams and photographs.

➢ **Discussion:**

Discussion allows you to express your point of view. It begins with a summary of the work carried out, and must answer the following three points: Has the initial objective been achieved? Are the results reliable? Judging the quality and validity of results through critical and objective discussion. How do the results compare to those of other authors?

- **Conclusion and perspectives**

It must be concise and address the subject; rather, it is a summary of the results. It will have to answer the research questions and confirm the validity of the hypotheses. It can also mention other possible methods of studying the subject; it can also open up new avenues and suggest other studies (perspectives).

- **Bibliographic references**

This is an important part of the dissertation and must be prepared carefully. We advise you to use bibliographic reference management software from the beginning of the documentary search (Zotero, EndNote, Mendeley, etc.). The bibliography includes all the documents (books, journals, reports, websites, etc.) consulted for the production and writing of the work. They are organized in alphabetical order by author.

Examples: Akalin E., Ertug F. 2003. An anatomical and ethnobotanical study on ruta species in Turkey. J. fac. Pharm. Istanbul., 35-36 (2): 121-132. (Scientific article).

Bruneton J. 1999. Pharmacognosy, photochemistry, medicinal plants, 3rd Ed. Technique and documentation. Lavoisier, Paris pp.263-267, 793-795. (Book).

- **Appendices**

Documents which were useful or even necessary for the study, but which would weigh down the text rather than facilitate understanding should be relegated to the end of the study (Appendices). The annexes must be complementary to the body of the dissertation. Example: the details of tables of figures those are too heavy to insert into the text, but whose appendix allows for verifications, photos, illustrations or maps to better understand the elements that can be visualized, etc.

The appendices inserted must be useful for the dissertation.

- **The back cover**

Also cardboard, it includes for theses and research dissertations, the abstract of the work and the key words in the three languages (Arabic, French and English).

2.4.4.3 Formatting

The writing must be clear and simple. Sentences should be short. Complex sentences that are difficult to understand should be avoided. A sentence begins with a capital letter and ends with a point. One idea per sentence.

✓ **Character size:**

Characters of 12 for the body of the text,

- A margin of 3 cm on the left and 2 on the right,
- A margin of 2.5 cm at the top, 2.5 cm at the bottom,
- Single line spacing of 1.5.

Maintain the same font size throughout the text. You can use larger or bolder font for titles. Use the “justify” function of the word processor; it allows you to obtain lines that are all the same length.

✓ **The font:**

Choose Times New Roman.

✓ **Header and footer:**

This Word function can allow you, for example, to number the dissertation pages at the bottom of the page, and recall at the header of each page, the title of your dissertation, or the title of the chapter.

✓ **References in the text:**

In the body of the text, they appear in parentheses:

* If only one author: (Author name, year of publication). Example :(Böhme, 2014).

* If two authors: (Name of the 1st author and name of the 2nd author, year of publication) Example: (Akalin and Ertug, 2003).

*If more than two authors: (Name of 1st author *et al*., year of publication). Example: (Alelig *et al* ., 2003).

✓ **Figures and tables:**

The body of the text can usefully be accompanied by figures (diagrams, graphs, boxes, photographs) and tables,

Figures and tables are preceded by a number and an explicit title specifying their content. They must be announced in the body of the text.

Figures and tables actually have several functions, they:

- Illustrate the text;
- Synthesize developments;
- Aerate the presentation and make reading the text easier.
- Must be informative and not repeat text.
- Are not obligatory.
- Provide maximum information in minimum space.
- Must be understandable independently of the text.
- Must be informative in themselves due to their captions, subtitles, notes.

- Avoid “all figures” or “all tables”.

- The figures are always accompanied by legends and their titles are written at the bottom.
- Table titles are written at the top of the table. The body of the table should only contain numbers, never units of measurement, never percentages after a number.

- The choice between figure or table will depend on the objective sought.

✓ **Page numbering:**

The pagination starts from the introduction. The cover pages, dedications, acknowledgements, abstract, list of figures and tables are not numbered.

✓ **The punctuation:**

It serves to give rhythm to a text, but it also has a functional role: it contributes to the meaning of the text and makes it understood by others. It is therefore important to use it with precision (see table 2).

Table 2 : Rules regarding spaces.

		Space before sign	Space after the sign
The point	.	No	Yes
The comma	,	No	Yes
The suspension point	…	No	Yes
The semicolon	;	Yes	Yes
The two points	:	Yes	Yes
The exclamation point	!	Yes	Yes
The question mark	?	Yes	Yes
The dash	_	Yes	Yes
The hyphen	-	No	No
The apostrophe	’	No	No
		Space Outside	Space inside
The brackets	(….)	Yes	No
The hooks	[…]	Yes	No
The quotation marks	« … »	Yes	Yes

2.4.5 Scientific communication

Communication in the world of science could be divided in two types: oral or written presentation. The typical oral form of communication in science is the conference presentation, but it could be also a lecture, a talk or a reading for a non-specialist audience for the dissemination of results of scientific research. Written communication depends on articles for colleagues and professionals, as well as for the non-specialist.

The perfect communication between scientists should be open, fair, patient/ calm, helpful/supportive, constructive/creative. These variables are strictly connected to the attitudes of people, not to the formal values of the texts or any kind of message.

Scientific communication refers to all works of dissemination of theories and scientific results. Scientific communication can take the form of articles, books, presentations (papers) in colloquium or congress.

The aim of scientific communication is, as the name suggests, to communicate and transmit information effectively to listeners. Whatever the content, the ultimate goal must be to get the intended message across clearly, concisely and effectively.

Scientific communication should be organized and moderated in a specific way. The main role of moderators is to create a space for equal communication. In written communication, this means moderation of unfair reviews and unjust comments. In oral communication, fair discussion means fair time management and equal opportunity for presenting the theses of everyone, regardless of title and position.

2.4.5.1 Poster presentation

Posters are a key component of communicating your science and an important element in a successful scientific career. Posters, while delivering the same high-quality science, offer a different medium from either oral presentations or published papers, and should be treated accordingly. Posters should be considered a snapshot of your work intended to engage colleagues in a dialog about the work, or, if you are not present, to be a summary that will encourage the reader to want to learn more.

Poster presentations have become an important part of professional meetings and are recognized as valuable tools for teaching and assessment.

2.4.5.1.1 Definition

A “poster” is a printed or written notice displayed in a public place to announce something or advertise something. A scientific poster (Fig.1) is an illustrated summary of research that scientists and engineers use to present their scientific discoveries to larger audiences. A typical poster is printed on paper with determined dimensions

Posters are displayed at events such as symposiums, conferences and meetings to show new discoveries, new results and new information to scientists and engineers from different fields.

Posters have also been recognized as valuable tools for teaching and assessment.

2.4.5.1.2 Characteristics of a scientific poster

1. Organized, clean and simple design.
2. Focused on one specific research topic that can be explained in 5-10 minutes.

3.Contains an abstract, introduction, materials & methods, results, discussion and references.

4. Has four to ten high-resolution figures and/or tables that describe the research in detail.

5. Contains minimal text, with figures and tables being the main focus.



Figure 16:Example of a scientific poster.

2.4.5.1.3 Poster size

The poster size depends on the event organizer and availability of the space with organizer. But generally, most acceptable size is 1meter X 1meter. Now à day, the durable electronically printed synthetic flex is used to present the poster instead of the paper sheets, poster stands of specific size is provided at the conference hall, where we have to hang or paste our presentation poster on the space allotted to us.

2.4.5.1.4 Parts of a poster

Scientific posters are organized systematically into the following sections: Title, Authors, Abstract, Introduction, Materials and Methods, Results, Discussion, Acknowledgments and References (Fig. 16). Organizing a poster in this manner allows the reader to quickly comprehend the major points of the research and to understand the significance of the work.

Title

The poster title should appear at the very top of the poster (Fig. 16). The title should be brief (e.g., less than 15 words), descriptive and summarize the most important results and findings. Words, adjectives and phrases that covey bias or human feelings should be avoided. Scientists strive to let the data speak for itself and allow the reader the chance to make up their own mind about an issue based on the data that is presented. To summarise, the title must:

- ✓ Inform the reader about what is contained within the poster.
- ✓ Summarize the most important research results and findings.
- ✓ Be simple and focused on the research.
- ✓ Be straight forward and matter of fact.
- ✓ Be clear and concise (e.g., less than 15 words).
- ✓ Avoid words or phrases that sensationalize findings and results, convey bias or provoke human emotion.

Authors and Institutions

- ➢ **Authors' names are typically listed in order of prominence:**

the person who completed most of the research appearing first in the author list and referred to as "first author". The "second author" would be the person who appears second in the author list and so on. The corresponding author is also often indicated on the poster and may appear as the last name in the author list. The corresponding author is the senior scientist who designed the research, supervised the work and obtained the funding to conduct the research.

- **Contact information for all authors (e.g., email, physical address, phone number) is provided:**

The name of the college, university or institution where the research was conducted is also provided with the authors' names. The email addresses and phone number of the corresponding author is also provided.

This information tells the reader who conducted the research and where it was done.

Abstract

Unless required, abstract should not be included in the poster, when included, it can be very short, about 50 words.

Introduction

It is used to introduce the reader to the topic and provide all the necessary information needed to understand the topic. It describes the importance of the research, especially in context to previous work that has been conducted in this area. It helps to set the stage for the research described in the poster and provides clear objectives for why the work was conducted. The Introduction section (Fig. 16) frequently contains photographs, diagrams and tables that help to organize especially complex data for the reader to better understand. The introduction section of a poster should be as brief as possible, about 200-250 words.

Materials and Methods

This section appears in the poster immediately after the Introduction section. it is used by other scientists as a guide to reproduce and critically evaluate the research. It must:

1. Tell the reader how the research was conducted.
2. Provide detailed information about the techniques, methods, instruments and equipment used in the research.
3. Tell the reader who conducted the research, how data was collected, when and where work was completed.
4. Give information about the materials that were used in the experiments.

We can use tables, map, figures and pictures in this section as they will be more informative than the words. This section should be as brief as possible, not more than 250 words.

Results and Discussion

These sections are often combined in a poster in order to save precious space on a poster for the many pieces of information that a scientist would like to tell their audience and by combining the two sections, it becomes easier for the audience to understand the significance of the research.

The results and discussion section should contain data, typically in the form of a graph, histogram, chart, image, color-coded map or table.

An audience will be attracted to a poster because of its figures and so it is very important for the author to pay particular attention to the creation, design and placement of the figures in a poster (Fig. 16). A good figure is one that is informative, easy to comprehend and allows the reader to understand the significance of the data and experiment. Very often an author will use colours to draw attention to a figure.

The discussion section should state the importance of the research that is presented in the poster. It should provide an interpretation of the results, especially in context to previously published research. It may propose future experiments that need to be conducted as a result of the research presented in the poster. It should clearly illustrate the significance of the research with regards to new knowledge, understanding and/or discoveries that were made as part of the research.

The word limit for this section should be 200 to 300 words depending upon the type of study.

Conclusion

Use the conclusions section for stating the impact and significance of the study and future plans on further research.

References

The references (or Bibliography) section should list all the sources of information that were used in the poster. This section appears at the end of the poster. The References section typically contains all journal articles.

1. It provides the reader with information about who conducted the research, when it was published and the journal that published the work.
2. Provides detailed information about author names, article title, journal name, volume, issue and page numbers so that readers can easily find the source of the information.
3. Acknowledge the scientist(s) who conducted the research and/or the journal article where the research was originally published.

In posters, in-text citations are used to tell the reader where information was obtained. An in-text citation should appear after every sentence in the poster that describes the work of others. This includes all sentences that describe discoveries, findings, data, information, experiments, results, techniques, methods, dates, locations, etc.

In-text citations can be done using either **(1)** superscript numbers or **(2)** authors last name, followed by year published. **Example**:

(1): The defatted residue was added to 500 ml of methanol (90%) and allowed to macerate at room temperature for one week [1].

(2): The defatted residue was added to 500 ml of methanol (90%) and allowed to macerate at room temperature for one week (Sofowora,2010).

The number of references we cite should be few must not be more than 10

Acknowledgements

The acknowledgements section typically appears last in a poster and is where an author will list the people who contributed to the research We should thank the funding agencies for the research, and those who directly contributed to the work, this section should be as brief as possible, 2 -3 lines.

2.4.5.1.5 Poster text

The poster must be visually attractive in order to catch the reader's attention, which is why it should be airy, aesthetic, and easy to read.

The ideal poster consists of 30% text, 40% illustrations, and 30% white space. White space is important because it helps to make the poster more breathable and also adds dynamism.

To make reading easier, it is recommended to use short sentences and a sans-serif font (e.g., Arial or Helvetica), large enough to be readable from a distance of 2 meters (at least 24 points), except for references, which do not need to be legible from afar.

The title is more noticeable if it is in colour, bold, and at least 36 points in size. The text is usually written in black on a light or white background.

A. Text spacing and alignment:

The text of important section such as Introduction, Material and methods, Results and conclusion should be printed in double space and left alignment. Less important sections such as Acknowledgement and References may be printed as one and half or single space,

B. Font type and size:

- The font type and size should be such that the words can be viewed and resolved from a distance of 2 meters
- We should use only one font type or at the most two but not more than two.
- Times News Roman, Arial and Helvetica are easy to read types and we can use any one or two of them.
- The font size should not be less than (24), Title (36), Section Headings (28) and other general subheadings and text (24).

C. Emphasis:

To highlight certain words or phrases in the text we can format them with bold and for underlining, Italics can be used for the scientific names of the organisms, but should not be underlined.

D. Use of upper case:

It is better not to use all upper-case types in the poster, because text may become difficult to read

E. Use of colours:

- The colours chosen for text should have high contrast to the background colour, for examples: Black or blue text colour on white or very light grey background.
- We can also use two or three different light colours to fill the text boxes of different sections (introduction, material and methods, etc.) in order to break the monotony,

2.4.5.1.6 Poster Presentation

The presenter is the scientist or engineer who conducted the research. The presenter should:

- Dress professionally and understand all parts of the poster.
- Be confident (but not arrogant) when presenting the research to their audience.
- Understand everything that is in their poster (e.g., issue, topic, figures, tables, references).
- Relax, speak clearly, start with the introduction, move through the methods, results and end with the discussion section.
- Engage in conservation with the audience and answer their questions during the poster presentation.
- not read word-for-word from a script, but rather they should follow a general progression through their poster and should use figures and tables to communicate with

the audience and and don't exceed the time allocated for the presentation because a typical presentation lasts 5-10 minutes.

2.4.5.1.7 Poster design software's

There are several software programs that you can use to create a poster. When choosing a program, consider what software you have access to, what you are comfortable using, and whether or not you are willing to learn a new program. Here are a few programs that you can use to make your poster:



Adobe InDesign

Recommended program for creating posters. InDesign has page design and layout features that allow you to create a polished and professional poster.



Adobe Illustrator

Typically used for creating vector graphics, such as logos, diagrams and illustrations. Can be used to make posters.



Microsoft Publisher

Microsoft's program for page design and layout. Not as sophisticated as InDesign, but may be easier to learn how to use due to general familiarity with Microsoft products.



Microsoft PowerPoint

PowerPoint is easy-to-use and probably already installed on your computer. Can be used to make posters.



Canva

Canva is highly popular for group collaboration, offering a vast library of templates and design elements. Its drag-and-drop interface makes it easy for users of all skill levels to create professional-quality designs quickly and efficiently.

2.4.5.1.8 Importance of poster presentation

1. **Effective knowledge dissemination**
    - Posters allow researchers to summarize their work in a visually appealing and digestible format.
    - This is especially useful at conferences where time and attention spans are limited.
2. **Facilitates networking and collaboration**
    - Poster sessions promote direct interaction with peers, experts, and potential collaborators.
    - Unlike oral presentations, posters offer more time for discussion and exchange of ideas.
3. **Enhances communication skills**
    - Creating and presenting a poster enhances the researcher's ability to communicate complex ideas clearly and concisely.
    - Presenters learn to tailor their message for different audiences.
4. **Early career exposure**
    - For students and early-career researchers, poster presentations offer a low-pressure environment to showcase their work and gain confidence.
5. **Opportunities for feedback**
    - Posters often invite critical and constructive feedback from a variety of experts, helping refine the research or inform future directions.

2.4.5.2 Oral presentation

2.4.5.2.1 Definition

An oral presentation is one of the several forms of science communication and needs to be tailor-made depending upon the audience and ambience, the audience for oral communication may be students, researchers, peers, public or a combination of all these people.

An oral presentation involves the exchange of information with the audience.

The different contexts where presentations are required to be made include: student presentations as part of the academic program: seminars, journal club reviews; presentations at conferences or scientific meetings; lecture presentations, defending presentations such as thesis defense, presentations to funding agencies or review committees; presentations as part of job interviews; and presentations for a general audience to engage the public. The presenter should find out the context and audience before preparing for the presentation.

Oral presentation is an art that develops with practice.

2.4.5.2.2 Key points to prepare the presentation

•Understand the ambience and audience beforehand

• The presentation should take the audience from the known to the unknown and should have a take-home message

• The presentation should address a question and explain its relevance

• Contain crucial information

• The content should be based on the purpose of the presentation—Is it to educate, inform or persuade?

• It should have concise data

• It should be tailor-made for the target audience

• Rehearse the presentation and time it reshapes the content of required

• Prepare to be able to present at any time and even without the supporting content

• Engage the audience

2.4.5.2.3 Style of presentation

If we have the freedom to choose the style of presentation there are some important aspects to consider:

– White, plain backgrounds are preferable.

– Respect margins, align images or text boxes.

– Maintain a common theme and format, avoid mixing backgrounds or slide designs.

– Avoid overloading slides with too many animations, icons, clip-art, etc.

– Avoid complex transition effects between slides or too much animated input/output text.

– The font size should be appropriate for a good view in the room, and the font should be easy to read (Calibri, Tahoma, etc.). If, when preparing the slide, the font size has to be reduced, it is probably necessary to eliminate text, not reduce its size.

– Use simple sentences, spaced far enough apart. Keep the line spacing of the text constant.

– Keep the position, colour and size of titles consistent between slides.

– If a logo or image is placed to appear on all slides, keep its position and size. It is best to include it directly in the template layout, not manually on each slide.

– Keep text formatting consistent (capital letters at the beginning of sentences, full stops at the end, etc.), and avoid excessive abbreviations.

– Check spelling mistakes, punctuation, typographical errors or unnecessary spaces.

– Avoid red or green text if possible (consideration for the audience, given the possibility of colour blindness) or other text colours that do not display correctly.
– When presenting experimental data in a table, select the most representative results. It is a good idea to use different fonts or contrasting colours to distinguish the numbers that are most important or those that are outliers.

2.4.5.2.4 Content of oral presentation (Guidelines for oral presentation)

Presentation at a conference is a professional way of sharing scientific information. It could be sharing of an observation, detailed findings from a research project or introduction of a novel hypothesis. It could also be a comprehensive sharing of the current knowledge or state of the art and providing future directions. These presentations make conferences memorable for both presenters and the audience.

The content used for the oral presentation is same as that of poster presentation or research paper, the only difference is that you have enough space to use your creativity for conveying your message or research finding to audience.

For the conference presentations that contain data from original research, it is advised to follow the accepted abstracts and the IMRaD format: Introduction, Methods, Results and Discussion (Conclusions). So oral presentation must contain:

Title slide

It should contain:

- Name of the event, date of the event, type of activity, topic name,
- The full title of the presentation,
- Presenting author's details (if there is more than one author),
- Affiliation and Email address of the presenting author,
- Logos and picture of the institute.

Remarque: All authors can be listed if space permits, else they can be listed in the acknowledgements slide.

Introduction

- The introduction should be short,
- Background of the study using bullet points,
- Bring out the lacunae in the background and state the objectives of the study,
- Another tip is to start with an image, quote or question that captures the audience's attention and arouses interest.

Methods

- Should be brief but sufficient enough to understand the flow of the work and techniques involved; It is essential to correctly define the methodology used in the study, as the value of the results will depend on its quality. The type and design of the study, how the data were evaluated, sample size, study period, variables included, etc. must be defined
- It is important to avoid including too much text on the slides. Where possible, pictures, diagrams or even a short explanatory video can be introduced.

Results

It should be the central part of the presentation:

- The flow of results should mirror the objectives,
- The title of the slide should reflect the findings presented on the slide,
- Use graphs, pictures or other graphical representations of good resolution with large visible fonts, but avoid overloading the slides. It is preferable to put one graph/figure per slide, so that it is clearly visible and the audience can focus their attention,
- Use tables sparsely, where required.

Discussion

- Detailed discussion is not required,
- Study limitations if any may be included.

Conclusions

- They should be clear and concise,
- State succinctly the findings from the study, in other words summarise the most relevant aspects of the content presented and represent the "final message" that we want the viewer to remember,
- Future directions can be included.

Acknowledgments

- Include study funders, participants and people who are not listed as co-authors.

2.4.5.2.5 How to present effectively?

For meaningful and effective communication, we have to prepare our oral presentation in advance by taking in to consideration the nature of the audience. To prepare meaningful power point presentation, the presenter should have answers to Why? (Purpose of presentation], Who?

(Nature of audience), What? (Content of the presentation), How? (Communication skills) and where? When? (Schedule management).

To summarize a good and well oral presentation is appreciated by the audience: its scientific content; the manner of presentation; the way one interacts with the audience, so it is necessary to:

1. **Know your audience**

- Tailor content to their interests, knowledge level, and needs.
- Use relevant examples and avoid jargon (unless you're sure they understand it).

2. **Structure your presentation**

- Introduction: grab attention, state your purpose, and preview main points.
- Body: present main ideas logically, supported by evidence or stories.
- Conclusion: summarize key points and end with a strong closing message.
- One idea per slide and know much more than the content on the slides
- Limit the data presented to only the most important.
- Do not put too much text on one slide. More importantly, do not read the text to your audience word by word. If the text is important, just rephrase it and/or highlight the most important parts of the text.

3. **Use visual aids wisely**

- Slides should enhance your message, not distract.
- Use bullet points, visuals, and charts instead of blocks of text.
- Follow the "10-20-30 rule": 10 slides, 20 minutes, 30-point font.

4. **Practice delivery**

- Rehearse out loud multiple times.
- Time your presentation to ensure it fits the limit.
- Record yourself and watch for pacing, filler words, and body language.

5. **Engage the audience**

- Ask questions, encourage participation, or share relatable stories.
- Maintain eye contact and adjust tone and pace to keep interest.

6. **Manage nervousness**

- Breathe deeply, focus on your message (not yourself), and start with a smile.
- Preparation and practice significantly reduce anxiety.

7. **Use confident body language**

- Stand tall, use hand gestures naturally, and avoid pacing or fidgeting.

- Smile and make eye contact to connect with your audience.

2.4.5.2.6 Importance of oral presentation

1. Enhances communication skills:

Helps individuals articulate thoughts clearly and confidently and encourages the use of non-verbal cues like tone, facial expressions, and gestures.

2. Builds confidence:

Reduces anxiety and boosts self-esteem.

3. Improves critical thinking:

Presenters must analyse their topic, organize content logically, and anticipate audience questions.

4. Engages the audience:

Effective presentations can inform, inspire, or influence audiences more directly than written communication also helps foster discussion and interaction.

5. Valuable in academic and professional settings:

In academia, oral presentations are part of assessments and conferences and in professional settings, they're essential for meetings, pitches, training, and project updates.

6. Strengthens persuasion skills:

A well-structured oral presentation can change opinions, influence decisions, and promote action.

2.5 Bibliographic citation and referencing method

Academic institutions and scientific journals require that all sources consulted during the writing process be properly cited and referenced. However, many students and researchers perceive this task as complex, time-consuming, and demanding. The difficulty is further amplified by the wide variety of information sources used in academic writing, including term papers, essays, articles, and research projects.

These sources encompass both print and non-print materials, such as books, journals, magazines, newspapers, reports, students' academic works (including theses and dissertations), dictionaries, encyclopedias, letters, lecture notes, posters, manuals, brochures, directories, and photographs. In addition, electronic resources such as web pages, social media content, archived emails and messages, and online audio and video files also constitute important reference materials that must be cited accurately.

2.5.1 What should you reference?

When writing an academic paper, you must acknowledge and reference all sources of information that you use. This includes theories, definitions, research findings, concepts, and any ideas that are not originally yours. Proper referencing gives credit to the original authors and allows readers to verify your sources. However, there are two important exceptions to this rule.

- ✓ **Common knowledge**

You do not need to provide a reference for information that is considered common knowledge. Common knowledge refers to facts that are widely known, generally accepted, and cannot be traced to a single author. These are facts commonly found in textbooks and basic academic materials. **Example**:

- Photosynthesis is the process by which green plants convert light energy into chemical energy.
- The human body contains 46 chromosomes.

- ✓ **Your own ideas and arguments**

The second exception concerns ideas or arguments that you personally develop. After reading course materials and conducting research, you may analyse the information and present your own viewpoint or alternative explanation. In such cases, you do not need to reference your original argument.

2.5.2 Definitions

2.5.2.1 Quoting

Quoting is the most basic way to reference a source. It involves copying an author's exact words, placing them in quotation marks, and providing the appropriate citation. However, quotations should be used sparingly usually no more than one or two sentences because it is a bad way to synthesize information. Quotes are most appropriate when the original wording is difficult to paraphrase, such as when presenting a personal testimony, emphasizing a key idea, discussing a specific argument, or explaining a complex technical concept.

Example: "natural selection is the differential success in reproduction that results from the interaction between individuals that vary in heritable traits and their environment.**"** (Reece *et al*., 2017).

2.5.2.2 Paraphrasing

Paraphrasing is another method of referencing a source, and it involves expressing the author's ideas in your own words. It is often the most effective way to present factual details and complex concepts, and in academic writing, paraphrasing should be used more frequently than direct quotations. Effective paraphrasing requires more than simply substituting a few words with synonyms. You should completely restructure the sentences and adjust the organization of the ideas so they align with the purpose and flow of your paper. Merely copying a paragraph and altering a few terms does not qualify as paraphrasing. To avoid this, read the original text carefully, set it aside, and then write the information from memory. Focus on extracting the key points and presenting them clearly in a way that supports your argument or discussion.

2.5.2.3 Citing

Citations indicate where the information in your paper comes from, whether you are quoting or paraphrasing. Every source you use must be acknowledged both within the text of your essay and in the reference list at the end (fig.17).

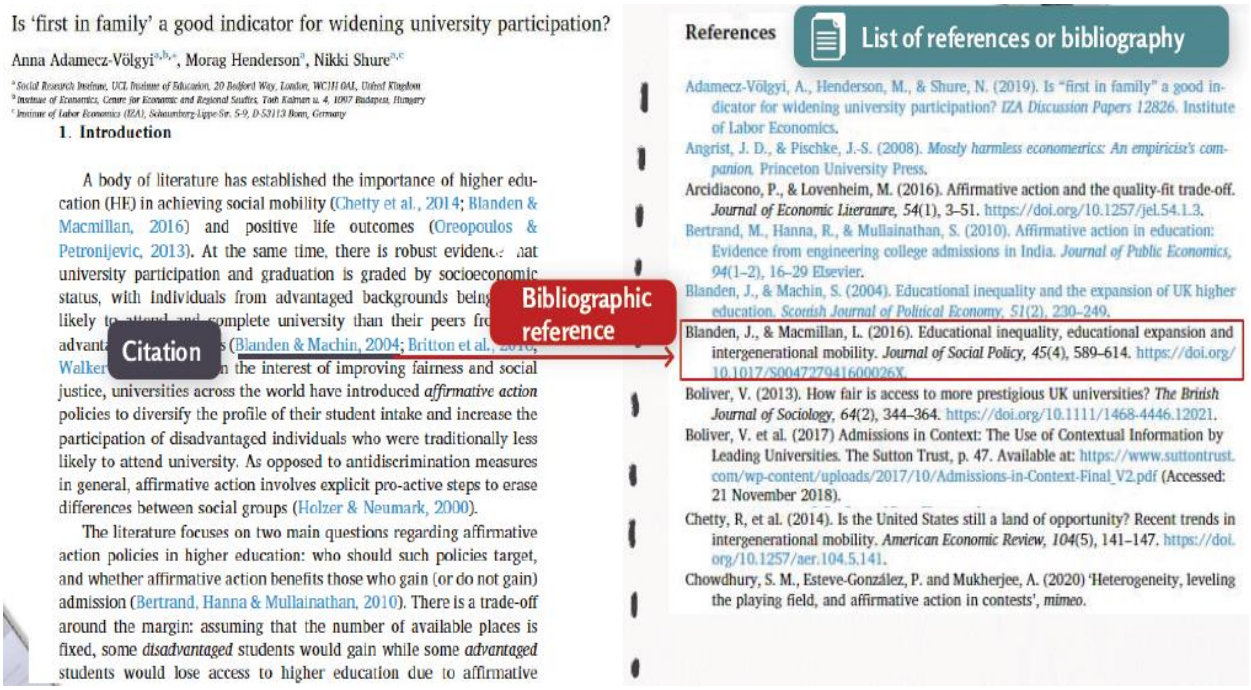


Figure 17: example of citation in text and in list of references.

There are two main ways to include in-text citations: you can mention the author's name as part of your sentence (**narrative in text citation**), or you can place the source information in parentheses after the referenced material (**parenthetical citation**). In-text citations provide only brief details, while the reference list contains the full publication information. The specific format and details required for both depend on the citation style you are using, such as APA method, MLA method, ...etc.

Examples:

Narrative in text citation: According to Pasteur L. (1861), microorganisms are responsible for fermentation.

Parenthetical citation: Microorganisms play a key role in fermentation processes (Pasteur L., 1861).

2.5.2.4 Referencing

In order to obtain a source cited within a text the reader needs more specific details about where that can locate that material. That's where references come in. the specific details provided by a reference depend on the type of source in question. Some details are common to all sources, for example the names of the authors and the date of publication. Other details are specific to particular sources, for example the volume and part number for a journal article (fig. 17). More details about referencing you will find it just below.



References

1. Palmintera D, Joy J, Xiang EX (2007) Technology transfer and commercialization partnerships. Innovation Associates Inc. www.InnovationAssociates.us. Accessed 5 Jan 2023
2. Michigan Technological University/Innovation and Commercialization. https://www.mtu.edu/research/innovation/. Accessed 1 Jan 2023
3. Jordan JF. First online date: 2018-06-29. Innovation, commercialization and the successful startup (Working Paper). https://kilthub.cmu.edu/articles/journal_contribution/Innovation_Commercialization_and_the_Successful_Startup/6471581. Accessed 1 Jan 2023
4. O'shea RP, Allen TJ, Morse KP et al (2007) Delineating the anatomy of an entrepreneurial university: the Massachusetts Institute of Technology experience. R & D Manag 37:1–16
5. Ravi R, Janodia MD (2022) Factors affecting technology transfer and commercialization of university research in India: a cross-sectional study. J Knowl Econ 13:787–803
6. Srivastava P, Sunita C (2012) Technology commercialization: Indian perspective. J Technol Manag Innov 7: 121–131
7. Kumar N, Pant G, Kulkarni SR (2018) The journey of the world's first non-steroidal contraceptive from Aca-

Figure 18: Example of list of references.

2.5.3 Importance of citation and referencing

The following are valid reasons why students and researchers must refer to, quote, and cite sources in their academic writing.

- ✓ Proper referencing demonstrates that the research is substantial and grounded in established facts.
- ✓ It reveals the theoretical foundation upon which the study is built.
- ✓ Accurate citation enhances the dependability, reliability, and credibility of the research findings and conclusions.
- ✓ it enables interested readers to locate and consult the cited sources for further exploration and advancement of knowledge.
- ✓ Referencing is the only legitimate means of avoiding plagiarism an academic offense that may result in serious penalties, including the loss of grades, academic certificates, qualifications, or other related sanctions.

2.5.4 Citation approaches in the text

In scientific and academic writing, there are four main ways in which a student or researcher may cite sources within the text. These approaches help ensure clarity, accuracy, and proper acknowledgment of borrowed ideas.

A. Source referencing

Source referencing involves inserting a citation in brackets at the exact point where borrowed information, whether quoted or paraphrased (fig. 19), appears in the text. This method clearly indicates the origin of the idea and allows readers to trace it easily.

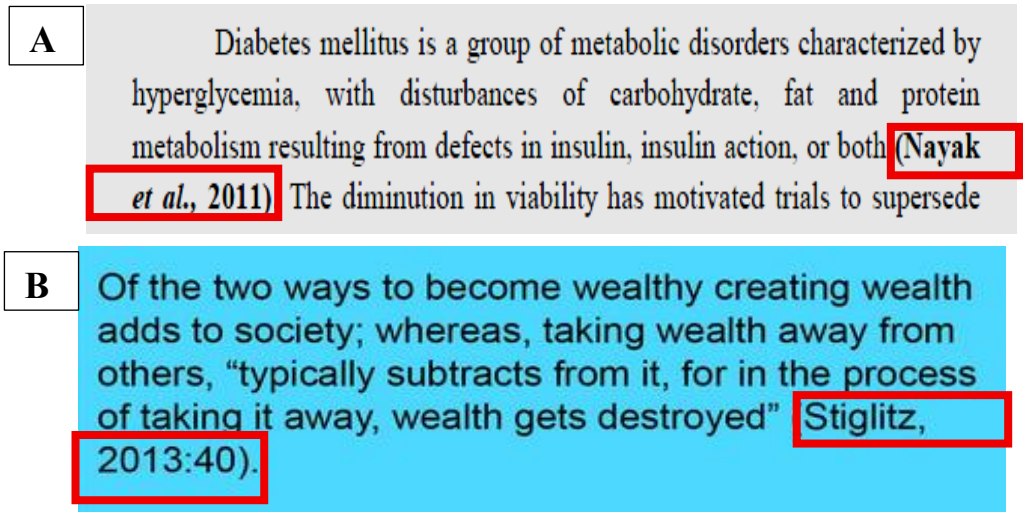


Figure 19: Example of source referencing (A) in paraphrased and (B) quoted cases.

B. Secondary referencing

Secondary referencing occurs when a writer cites a source that is mentioned in another work rather than consulting the original document directly.

In this case:

- The **primary source** is the original work being cited.
- The **secondary source** is the material currently being read, in which the primary source was found.

Both sources must be acknowledged in the text (fig. 20). However, only the secondary source the one actually consulted should be included in the reference list or bibliography. This method is used when the original source is unavailable for direct consultation.

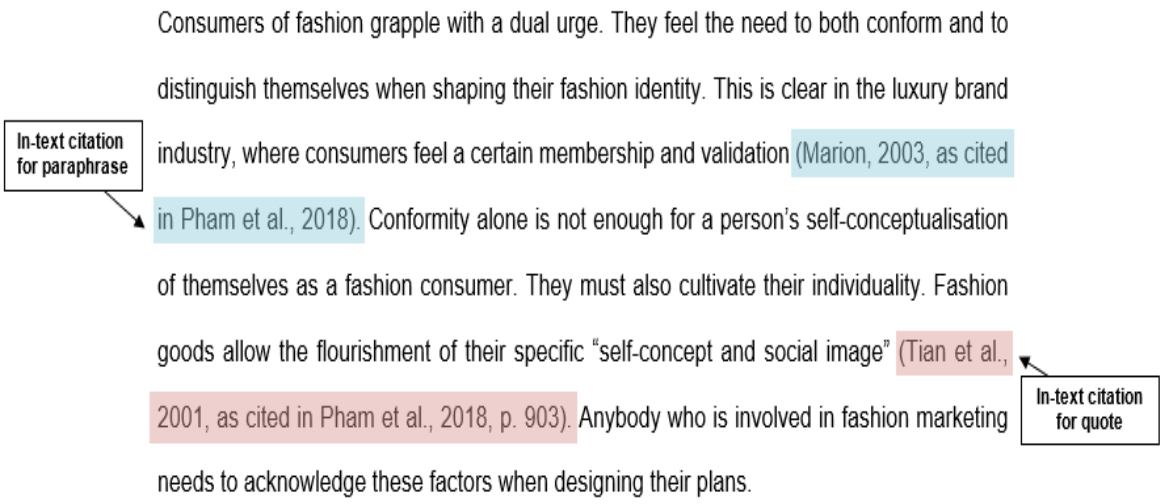


Figure 20: Example of secondary referencing in paraphrased and quoted cases respectively.

C. Cross-referencing

Cross-referencing refers to directing readers to another part of the same document, such as a chapter, section, table, figure, or paragraph. This type of reference must be precise and should indicate the specific number of the item rather than the page number.

Example: references should be made to "Chapter 3," "Table 2," or "Figure 1.4" instead of simply indicating a page: (see Chapter 3) (see Table 2), (see Figure 1.4)

When a cross-reference relates to a specific sentence, it should be incorporated into that sentence.

Example: "… GOT and GPT are indicators of hepatic cell damage (see Chapter 3)." Note that the word see begins with a lowercase letter in this case.

However, when the cross-reference applies to an entire paragraph, it should be placed after the final sentence of the paragraph. In this situation, *See* begins with a capital letter.

Example: "… GOT and GPT are indicators of hepatic cell damage (See Chapter 3)."

Also, observe that the referenced item (e.g., Chapter 3) is written with an initial capital letter.

D. Content referencing

Content referencing is used to provide supplementary information, clarification, or further explanation without interrupting the main flow of the text. According to Brunethon (1999), content referencing may serve to:

- Guide readers to additional sources for further study;

- Clarify specific information, such as identifying people or places or explaining foreign terms;
- Provide important details that cannot be included in the main text without disrupting coherence;
- Expand on a particular argument or viewpoint;
- Present the original wording of a passage that has been translated freely in the text.

Content referencing can be presented in two forms: **endnotes** and **footnotes**.

- **Endnotes** are placed on a separate page at the end of the document, before the reference or bibliography list. They are usually titled ENDNOTES or NOTES and are indicated in the text by superscript (raised Arabic numerals). Because readers must turn to another page to consult them, endnotes may be less convenient.

- **Footnotes** appear at the bottom of the same page where the reference is made. They are separated from the main text by extra space, a line, or smaller font size. Like endnotes, they are indicated by superscript numbers, typically placed at the end of a sentence and usually after the punctuation mark.

Example: the values of Follicle stimulating hormone [1] in pregnant pretreated rats were …

---

[1] Follicle stimulating hormone is a glycoprotein hormone, pulsatile secreted by the ante hypophysis gland.

These citations approaches ensure that academic writing remains transparent, organized, and properly documented.

2.5.5 Essential components of a reference

In general, references to all types of information sources must contain certain essential elements, known as bibliographic details. The main purpose of including these components is to provide complete and accurate information that enables readers to identify and retrieve the original source without difficulty.

Information sources are broadly divided into two categories: **print sources** and **non-print (electronic) sources**.

Print Sources

A standard reference entry for print materials usually includes the following components:

1. **Author**: This may be an individual author, multiple authors, an editor, a corporate body, a government institution, a conference, or any responsible organization.
2. **Date of publication**: Typically, the year of publication. For certain materials, the full date (day, month, and year) may be required.
    - If the publication year is unavailable, the copyright year may be used, preceded by the letter *c* (e.g., c2014).
    - If no date is available at all, the abbreviation *n.d.* (no date) is used.
3. **Title**: The full title of the book, article, or document.
4. **Edition**: If the material is not the first edition, the edition number should be indicated.
5. **Place of publication**: The city (and sometimes country) where the work was published.
6. **Publisher**: The name of the publishing company or institution.
7. **Volume, issue number, and/or page numbers**: Especially required for journal articles and book chapters.

Non-Print Sources (Electronic Materials)

When citing electronic or online materials, the following essential details should be provided whenever available:

1. **Name of the author or editor**
2. **Title of the page or article**
3. **Title of the website or web page** (often found on the homepage)
4. **Type of medium** (e.g., online journal, website, electronic document)
5. **Date of publication, last update, or copyright date**
6. **Full Internet address (URL)**
7. **Date of access** (the date the material was consulted)

We have outlined the essential components required in every reference entry. However, it is important to understand that each referencing style such as Harvard, APA, Vancouver, or MLA has its own specific rules for presenting these components. The order, formatting, punctuation, and overall arrangement of the elements vary according to the referencing method being used. Therefore, the structure of a reference entry depends entirely on the guidelines of the chosen citation style.

2.5.6 Referencing method

Different academic departments and faculties require different citation and referencing styles. This variation also applies to scientific journals and other professional publications.

Therefore, the first step for any student or researcher is to identify the specific referencing requirements of their department, faculty, or relevant professional or publishing body.

2.5.6.1 Harvard Method

The Harvard method, also referred to as the **author–date system**, is a citation and referencing style.

The Harvard method is characterized by the following general features:

- Cite the author(s) name(s), date of publication and page in the text (e.g. Ghedjati, 2012:21). For more than one author (Ghedjati, 2012:21; Bouras, 2014:14). etc.
- If author's name(s) forms part of the sentence, put the date and page in bracket.
- Page numbers are required only for works that are paginated.
- A comma is used to separate the author's name from the date, while a colon separates the date from the page number(s).
- Quotations containing fewer than 40 words should be incorporated into a grammatically correct sentence and smoothly integrated into a well-developed paragraph.
- When a quotation forms part of a sentence, the concluding punctuation mark is placed after the closing parenthesis of the citation.
- Any words omitted from a quotation must be indicated by ellipses (. . .).
- Quotations exceeding 40 words should be presented in a separate indented paragraph without quotation marks.
- All in-text citations are compiled systematically at the end of the paper under the heading "References," or under "Bibliography" if the list also includes additional relevant sources that were not directly cited.
- Entries in the reference list or bibliography must be arranged in alphabetical order.
- Only the titles of published works are italicized; titles of unpublished works are written without italics.
- If no author is identified, the title of the work should be used in place of the author's name both in the text and in the reference list.

Several examples of the in-text citation and referencing formats are presented below. where, "C" denotes citation which can be in type of narrative or parenthetical citation according to the structure of the sentence(s) while "R" denotes Reference.

- **Print sources**

1. Books:

- **One author**

C: author (year: page) the quoting or paraphrasing information.

R: Author surname, initial(s). year. Book title. Place of publication: Publisher's name.

- **Several books by one author**

C: author (year: page; year: page) the quoting or paraphrasing information.

R: They will be listed separately in the reference list and arranged chronologically.

- **Two authors**

C: (author 1& author 2 year: page) (&) is used as a conjuncture when the authors do not form part of the sentence. So, where the authors form part of the sentence, "and" is used for example: author 1 and author 2 (year: page) have shown that…

R: Author 1 & Author 2. year. Book title. Place of publication: Publisher's name.

- **More than two authors**

C: (author 1 *et al*., year: page) the same as the previous.

R: in the reference list/bibliography, all of the authors must be listed: Author 1, Author 2, Author 3 & Author 4. year. Book title. Place of publication: Publisher's name.

- **Corporate Body**

C: … has been confirmed by epidemiological studies (World Health Organization, 2020:45).

R: World Health Organization. 2020. Global tuberculosis report. Geneva: World Health Organization.

- **Unpublished conference paper**

C: (Okafor, 2018:12).

R: Okafor, T. C. 2018. Antibiotic resistance in rural communities. Paper presented at the Nigerian Society for Microbiology Conference. 15 March, Enugu.

- **Conference paper in published proceedings**

C:(Adeyemi, 2015:78).

R: Adeyemi, K. L. 2015. Climate change and marine biodiversity, in B. U. Eze & R. T. Bello (ed.). Emerging issues in environmental biology: proceedings of the National Biology Conference. Lagos: University of Lagos Press: 70–85.

- **A translated work**

C: (Darwin, 1859).

R: Charles Darwin. 1859. On the origin of species. W. Smith (tr.). London: John Murray.

- **Work in press**

C: (Ibrahim, 2023)

R: Ibrahim, A. M. 2023. Advances in plant genetic engineering (in press). Ibadan: Spectrum Books.

- **Chapter in edited book**

C: (Nwosu, 2017:33)

R: Nwosu, P. O. 2017. Cell division and heredity, in L. A. Mensah (ed.). Fundamentals of modern biology. Abuja: Academic Press: 30–50.

- **Unpublished thesis/dissertation**

C: (Eze, 2019:64)

R: Eze, C. N. 2019. Assessment of water pollution on freshwater fish in Anambra River. MSc thesis. Nsukka: University of Nigeria Nsukka.

2. Journals: Article in journal

(Italicize the title of the journal, NOT the article title)

C: (Okeke, 2016:25)

R: Okeke, J. C. 2016. Effects of temperature on enzyme activity in tropical fish. *African Journal of Biotechnology*, 15 (4): 20–32.

3. Weekly or daily periodicals (Newspapers / Magazines)

C: (Ahmed, 2020:14)

R: Ahmed, L. 2020. Rising malaria cases worry health experts. *The Guardian*, 12 August: 14.

4. Dictionaries and encyclopedias

C: (Encyclopaedia Britannica, 2010)

R: Encyclopaedia Britannica. 2010. s.v. “Photosynthesis”. Chicago: Encyclopaedia Britannica Inc.

- **Electronic references (online source)**

C: (Federal Ministry of Health, 2021)

R: Federal Ministry of Health. 2021. Malaria prevention campaign [Online]. Available: https://www.health.gov.ng/malaria-prevention [2021, 15 July]

2.5.6.2 APA Method

The APA referencing style uses an author/date convention in the writing itself (called in-text referencing) and a list of the sources at the end of a piece of writing (called references). In-text references are brief. The references list provides the detail that allows the sources to be found again. This method has as general rules the following:

- In in-text citation, include only the author's name(s) and the year of publication. Page number(s) are required only for direct quotations and for subsequent citations of paginated works.
- When a page number is necessary, it should be written as "p. 3" for a single page or "pp. 6–12" for multiple pages.
- If the author's name is mentioned as part of the sentence, only the year of publication should appear in parentheses.
- Use a comma to separate the author's name from the year and the page number where applicable, for example: (Ghedjati, 2012, p. 5).
- Quotations of fewer than 40 words should be incorporated into the sentence grammatically, either as a paraphrase or as a direct quotation within a well-structured paragraph.
- When a quotation forms part of a sentence, the final punctuation mark should be placed after the closing parenthesis of the citation.
- Words omitted from a quotation should be indicated with ellipses (. . .).
- Quotations exceeding 40 words should be presented as a separate indented paragraph, without quotation marks and without italics.
- For works with two to five authors, list all authors' surnames at the first citation. In subsequent citations, use the first author's surname followed by "et al." (not italicized).
- For works with six or more authors, use the first author's surname followed by "et al." in both the first and subsequent citations.
- In the reference list, include up to seven authors' names in full. If there are more than seven authors, list the first six names, followed by ellipses (. . .), and then add the final author's name.
- Use the conjunction "and" when citing authors within the text, but use the symbol "&" when listing authors in the reference list.
- All sources cited in the text must be listed systematically at the end of the work under "References." If additional relevant materials not cited in the text are included, the list should be titled "Bibliography."
- Entries in the reference list or bibliography should be arranged alphabetically.
- In the reference list, only the titles of works should be italicized.

Several examples of the in-text citation and referencing formats are presented below. where, "C" denotes citation which can be in type of narrative (Ghedjati (2023)). or parenthetical citation (Ghedjati, 2023) according to the structure of the sentence(s) while "R" denotes Reference.

- **Print Sources**

Books

C: Campbell (2014) agrees with World Health Organization (2012) that cell division is fundamental to growth and tissue repair.

R: Campbell, N. A. (2014). *Biology* (10th ed.). San Francisco: Pearson Education. World Health Organization. (2012). *Global health risks: Mortality and burden of disease attributable to selected major risks*. Geneva: WHO.

Chapter from an Edited Book

C: Uzuegbu and Aniedu (2012) opine that information management is essential in biological research and laboratory practice.

R: Uzuegbu, C. P. & Aniedu, O. N. (2012). Information search and retrieval in the internet age: Is there any need for the librarian? In R. U. Ononogbo, A. N. Uhegbu, M. C. Nwosu and C. P. Uzuegbu (Eds.), *Personnel issues in the 21st century librarianship* (pp. 91–101). Umuahia, Nigeria: Zeh Communications.

Dictionaries

C: The *Webster Universal Dictionary and Thesaurus* define enzymes as biological catalysts that speed up chemical reactions in cells.

R: *Webster Universal Dictionary and Thesaurus*. (2007). New Lanark, Scotland: Geddes and Grosset.

Encyclopedia

C: Hanegraaff (2005) explains that evolutionary theories attempt to describe the origin and diversification of living organisms.

R: Hanegraaff, W. (2005). Evolutionary theory. In L. Jones (Ed.), *Encyclopedia of biology* (2nd ed., Vol. 10, pp. 6495–6500).

Journal article with DOI

C: (Smith & Brown, 2020)

R: Smith, J. A., & Brown, L. K. (2020). Effects of temperature on enzyme activity in bacteria. *Journal of Experimental Biology, 223*(4), 112–120. https://doi.org/10.1234/jeb.2020.56789

Journals article without DOI

C: Pesticide toxins are harmful to aquatic organisms (Shaffril & Uli, 2010).

R: Shaffril, H. & Uli, J. (2010). The influence of socio-demographic factors on environmental awareness among rural farmers. *The Journal of International Social Research*, 3(10), 459–469.

Magazines

C: Allan (2004) agrees with the findings on food contamination and public health risks.

R: Allan, B. (2004, March). The food fight: Biological safety and consumer health. *Consumer*, 438, 8–11.

Technical reports

C: The working document on disease control among nurses (National League for Nursing, 1990) highlights infection-prevention strategies.

R: National League for Nursing. (1990). *Self-study report for community health organizations* (Pub. No. 21–2329). New York, NY: Author.

Published conference proceedings

C: Ezeani, Eke and Ugwu (2012) submit that professionalism enhances biological research and laboratory ethics.

R: Ezeani, C. N., Eke, N. E. & Ugwu, F. (2012). Professionalism in biological and medical information services. In *Proceedings of the Nigerian Library Association 50th Conference and Annual General Meeting*, Abuja, July 15–19, 2012.

Unpublished conference / workshop paper

R: Oketunji, I. (1998). Relevance of biological classification systems to automated cataloguing. Paper presented at the 18th NLA Cataloguing, Classification and Indexing Workshop, Kwara State Library Board, Ilorin, 26–30 October.

Theses and dissertations

R: Amanze, K. C. (2010). *Nursing management of rheumatic fever and its biological implications* (Unpublished master's thesis). University of Nigeria, Nsukka, Nigeria.

Abstract only

R: Woolf, N. J., Young, S. F., Fanselow, M. S., & Butcher, L. L. (1991). MAP-2 expression in neurons of rodent cortex altered by Pavlovian conditioning [Abstract]. *Society for Neuroscience Abstracts*, 17, 480.

Poster presented at conferences

R: Ibegwam, A., Anasi, S. N. I., & Uzuegbu, C. P. (2013, July). The role of agricultural biology libraries in promoting rural health literacy. Poster presented at the Conference of the International Association of Agricultural Information Specialists (IAALD), Cornell University, Ithaca, NY, USA.

- **Non-print sources**

Internet / ERIC

R: Lopez, J. (2005). *Characteristics of selected biology education programs worldwide* (Unpublished master's thesis). Dominican University of California. Retrieved from ERIC database (ED491402).

Brewster, C., & Railsback, J. (2002). *Full-day science programs and extended biological learning*. Retrieved from ERIC database (ED472733).

Internet: Commercial databases

R: Gonzalez-Mena, J. (2007). *Biological diversity and early science education*. Available from FindArticles database.

Saarivirta-Kolpack, M. (2006). *A history of biological teacher training practices* (Master's thesis). Available from ProQuest Dissertations & Theses database (UMI No. 1439820).

Internet: Non-commercial sites

R: Vogel, C. G. (1999). *Legends of landforms: Biological and geological interpretations of natural landscapes* [Adobe Reader version]. Retrieved from NetLibrary.

2.5.6.3 The Vancouver method

The Vancouver method is a **numerical referencing system** mainly used in medicine, computer science, and mathematics. It follows a structured numbering format. The main characteristics of this method are:

- Each source is assigned a number the first time it is cited in the text.
- This number appears either in superscript ([1]) or in square brackets [1].
- The same number is used every time that particular source is cited throughout the text.
- Even when the author's name is mentioned in the sentence, the assigned number must still be included.
- Full bibliographic details are provided at the end of the document in a reference list arranged in numerical order according to their appearance in the text. Only cited sources are included.
- In the reference list, entries are not indented, and a blank line is left between each reference.

- Unlike Harvard and APA styles, titles are not italicized, and the year of publication appears at the end of the reference.
- Journal titles are abbreviated according to the Index Medicus standard (e.g., *African Journal for Health Science* becomes *Afr J Health Sci*).
- The Index Medicus abbreviation list is available from the U.S. National Library of Medicine website.
- In the reference list, authors' surnames and initials are written without punctuation (e.g., Abiodun KE). Multiple authors are separated by commas, not by an ampersand (&).
- When citing multiple sources at the same point, each source is given its own number.
- If the square bracket system is used, page numbers may optionally be included (e.g., [2:45]).
- Quotations are handled in the same way as in Harvard and APA styles.

Advantages of the Vancouver method

- It makes the main text easier to read.
- It avoids long author-date citations that interrupt the flow of writing.
- References are listed in the same order as they appear in the text, so readers do not need to search through an alphabetical list.

Disadvantage

- Readers must frequently refer back to the reference list to identify the authors of cited works.

➢ **Examples of the Vancouver method**

Books: One author

C: This condition is common in elderly patients as explained by Kumar[2] in …
Or
C: This condition is common in elderly patients as explained by Kumar [2] in …
R: Kumar P. Clinical medicine. 9th edition. London: Elsevier; 2017.
If the citation refers to a group of sentences, the number is placed after the final full stop:
C: Hypertension increases the risk of stroke and myocardial infarction. It is often asymptomatic in early stages. [2]

Books: Two to six authors

C: Recent studies on cardiovascular diseases show significant improvements in therapy [1] …
R: Hall JE, Guyton AC, Hall ME. Textbook of medical physiology. 14th edition. Philadelphia: Elsevier; 2021.

Books: More than six authors

(If more than six authors, list the first three followed by *et al.*)

R: Jameson JL, Fauci AS, Kasper DL et al. Harrison's principles of internal medicine. 21st edition. New York: McGraw-Hill; 2022.

Books: Corporate body

R: World Health Organization. Global tuberculosis report. Geneva: WHO Press; 2023.

Unpublished conference paper

R: Smith TR. Advances in minimally invasive cardiac surgery. Paper presented at the International Congress of Cardiology. Paris; 2018.

Conference paper in published proceedings

R: Ahmed S, Bello M, Okeke T. Emerging trends in malaria treatment in sub-Saharan Africa. In: Johnson P, editor. Proceedings of the International Conference on Tropical Medicine. Nairobi: Medical Press; 2020. pp. 112-118.

Chapter in an edited book

R: Brown MJ. Management of hypertension. In: Walker BR, Colledge NR, Ralston SH, editors. Davidson's principles and practice of medicine. 24th edition. Edinburgh: Elsevier; 2022. pp. 597-605.

Chapter in a book (no author)

R: Infection control in hospitals. In: Smith J, Roberts L, editors. Manual of clinical nursing. London: Health Press; 2019. pp. 88-95.

Unpublished thesis or dissertation

R: Ibrahim AA. Prevalence of anemia among pregnant women in rural communities [unpublished dissertation]. University of Lagos; 2016.

Journal article

R: Smith AB. Advances in cancer immunotherapy. N Engl J Med. 2020; 382(14): 1345-1356.

Class notes

C: The mechanism of insulin resistance was described by Hassan [4].

R: Hassan RM. Pathophysiology of diabetes mellitus. Unpublished class notes. Department of Medicine, University of Cairo; 2021.

Electronic references: CD-ROM or commercial database

R: Johnson T, Clark M. Human anatomy atlas [CD-ROM]. 2015 [retrieved 2023, June 12]; Available: MedLibrary Database.

Electronic journal article (online database)

R: Adeyemi O. Antimicrobial resistance patterns in Nigeria. Afr J Clin Exp Microbiol [Internet]. 2021 [retrieved 2024, January 10]; 22(3): 210-218. Available from: http://www.ajcem.org

Website (with author)

R: Centers for Disease Control and Prevention. Diabetes risk factors [Internet]. 2022 [retrieved 2024, February 15]; Available from: http://www.cdc.gov

Website (no author)

R: Symptoms of myocardial infarction [Internet]. 2021 [retrieved 2024, March 10]; Available from: http://www.heart-health.org

- **Example of a reference list**

[1] Brown MJ. Management of hypertension. In: Walker BR, Colledge NR, Ralston SH, editors. Davidson's principles and practice of medicine. 24th edition. Edinburgh: Elsevier; 2022. pp. 597-605.

[2] Kumar P. Clinical medicine. 9th edition. London: Elsevier; 2017.

[3] Smith AB. Advances in cancer immunotherapy. N Engl J Med. 2020; 382(14): 1345-1356.

[4] Ibrahim AA. Prevalence of anaemia among pregnant women in rural communities [unpublished dissertation]. University of Lagos; 2016.

2.5.6.4 The MLA method

The **MLA referencing method**, developed by the **Modern Language Association**, is mainly used in the humanities, particularly in fields such as linguistics and literary studies. Its main characteristics include the following:

- In the text, **the author's surname and the page number** are written in parentheses to indicate the source of the information.
- In this method, **the publication date is less important** and is generally not included in the in-text citation.
- **Titles of works are significant** in MLA style and should be mentioned in the text whenever possible. If a title is very long, it may be shortened using an ellipsis **(…)**.

- Every citation in the text must correspond to a complete reference listed at the end of the document. This list is known as **"Works Cited."**
- The **Works Cited list** is organized alphabetically according to the authors' surnames or, when there is no author, according to the title of the source.
- In this list, **the first line of each reference begins at the margin**, while the **second and subsequent lines are indented** (hanging indentation). Additionally, **one blank line separates each entry**.
- In MLA style, **authors' names are written in full** in the Works Cited list; **initials are not used**.
- Regarding punctuation and order of names, **the first author's surname appears first**, followed by their full given name. For the **second author**, the name is written in the normal order (first the given name, then the surname), with a comma placed before **"and."** For example: *Uzuegbu, Chimezie, and Cletus Okafor.*
- Concerning **quotations**, MLA treats them similarly to the **Harvard, APA,** and **Vancouver styles**. Quotations of **fewer than 40 words** are incorporated into the sentence and enclosed within quotation marks. Quotations of **40 words or more** are presented as a separate indented paragraph without quotation marks.

2.5.7 Bibliographic management software

It is important to keep a detailed record of all the articles, conference papers, books and other sources that one consults for academic purposes. It is easy to misplace or forget some things that were read. Personal bibliographic management software tools such as *RefWorks* and *Endnote* allow users to download all the necessary bibliographic details about library materials (e.g. online journal articles, books, conferences and other sources) into one's own personal database and to construct lists of references quickly and easily.

There are online tutorials and videos available for these products to show one how to use them, or one may ask a librarian for assistance. Alternatively, one may consider freely available or open access bibliographic management tools such as *Mendeley* or *Zotero*.

3 Reading and understanding a scientific article

The purpose and approach to reading a scientific article is unlike that of reading a news story, novel, or even a textbook and can initially seem unapproachable. Having good habits for reading scientific literature is key to setting oneself up for success, identifying new research questions, and filling in the gaps in one's current understanding; developing these good habits is the first crucial step.

3.1 Reading a scientific article

Reading a scientific paper is a completely different process from reading an article about science in a blog or newspaper. Not only do you read the sections in a different order than they're presented, but you also have to take notes, read it multiple times, and probably go look up other papers in order to understand some of the details. Reading a single paper may take you a very long time at first, but be patient with yourself. The process will go much faster as you gain experience.

Researchers must read papers for several reasons: to review them for a conference or a class, to keep current in their field, or for a literature survey of a new field. A typical researcher will likely spend hundreds of hours every year reading papers.

3.1.1 Definitions

Reading is clearly an important skill. In fact, it is much more than a single skill: it involves the coordination of a range of abilities, strategies, and knowledge.

Reading is a dialogue between the reader and the author.

Reading is the process of using one's eyes and mind to understand the literal as well as the hidden meaning of what the writer was to convey.

3.1.2 Reading Techniques

3.1.2.1 Scanning

Scanning is reading rapidly to find a specific piece of information (name, place, and time, etc). Meanwhile, it is a device used to locate details-specific question that may be asked at the end of the assignment, it is very useful for students to find specific information to get answers from the questions in the assignment or exam, and minimize their time to answer the questions in the text.

Scanning useful for finding quick answers (like in exams or research) and improves focus and attention to detail.

3.1.2.1.1 Scanning strategy

Th main purpose of scanning is to find specific information in limited period of time. Scanning is also used to determine whether a particular piece of information will answer one of the given questions. Scanning involves the identification of the paragraphs or sections that most probably contain the information you need and then look quickly through them; seeking key relevant words or keywords, numbers, names, or dates.

3.1.2.2 Skimming

Skimming is defined as a quick movement of the eyes through a text or article in order to get the main ideas and a general overview of the text. It is reading sections only, skipping to find the next section of interest. Skimming is reading at fastest speed which a person can accomplish, it is used when a reader wishes to cover material in a hurry.

Skimming saves time when you need just an overview and helps in deciding if a deeper read is needed.

3.1.2.2.1 Skimming strategy

Skimming strategy is helping students to read more actively and to find the general idea or the main idea of each paragraph by reading headings, subheadings, first and last sentences of paragraphs, look at any pictures or phrases that are in boldface or italics.

3.1.2.3 Intensive reading

Intensive reading is the type that involves short reading passages followed by textbook activities to develop comprehension and particular reading skills. It is the most time-consuming of all the reading techniques, in other words, reading carefully for complete understanding. The main goal here is to retain information for the long-term and to build critical thinking and analysis skills. This method is recommended especially for language students, or technical subjects. But it’s also great for analysing reports and detailed research.

3.1.2.4 Extensive reading

Extensive reading is a faster reading of longer passages to develop understanding of writers‟ organizational strategies, improve reading speed, and focus on the main ideas.

Reading longer texts for overall understanding and enjoyment by reading novels, articles, or long essays without stressing over every word.

Extensive reading is important to enhance reading fluency and vocabulary naturally and to encourages a love for reading.

3.1.3 Choosing the right article

Not all published research articles are excellent, so it's important to assess whether a study is worth reading. Readers should first select articles based on their specific needs and then read them methodically. A decision-making flowchart (Fig.21) is provided to help readers choose the appropriate type of article, particularly for those with a specific purpose in mind rather than casual browsing.

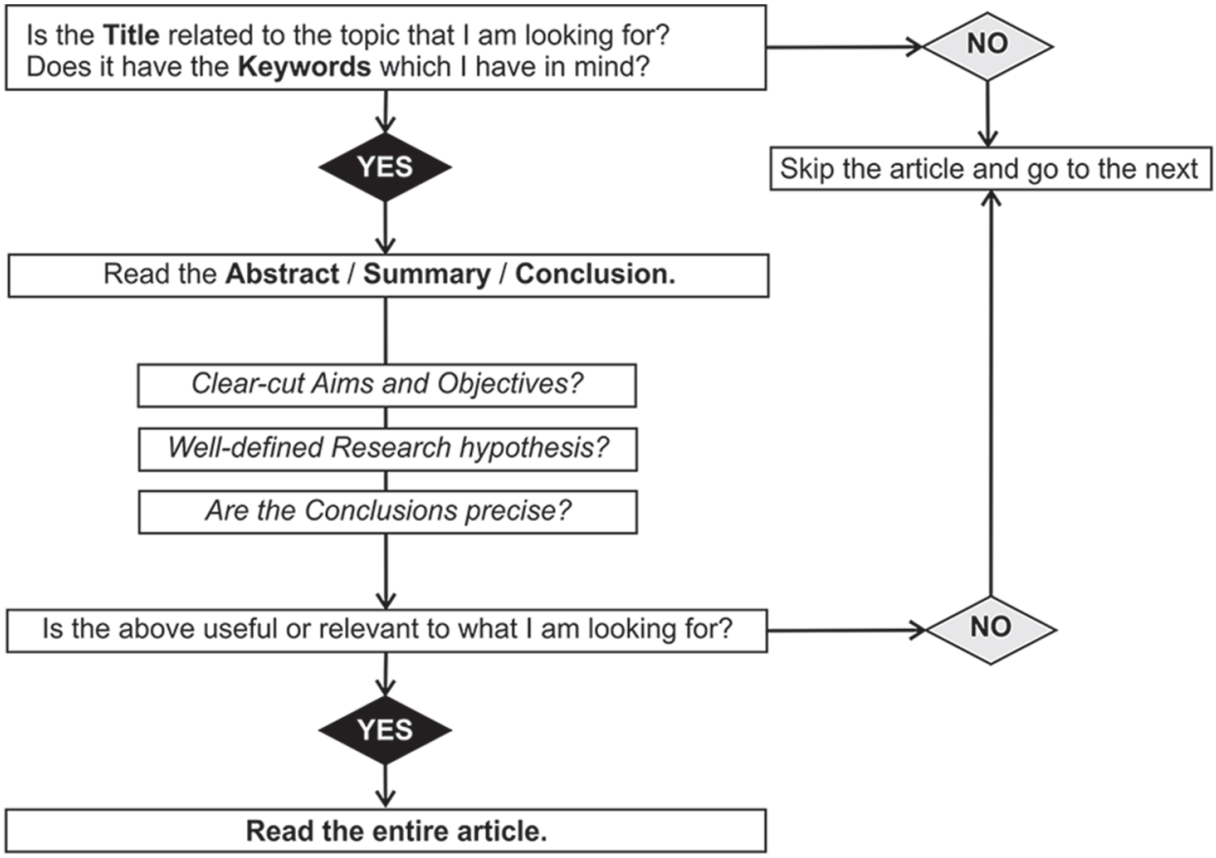


Figure 21: Decision-making flowchart to decide whether to read the chosen article or not.

3.1.4 How to read a paper?

The main concept is to read the paper in up to three stages rather than working straight through from start to finish. Each pass serves a distinct purpose and builds on the previous one:

- ✓ the first pass provides a broad overview of the paper,
- ✓ the second pass helps you understand the content without focusing on fine details, and
- ✓ the third pass enables a deep and thorough comprehension of the work.

3.1.4.1 The first pass

The first pass is a quick scan to grasp the paper's general idea and to decide whether deeper reading is necessary. It should take about five to ten minutes and involves these steps:

1. Carefully read the title, abstract, and introduction.
2. Read the section and sub-section headings, ignoring the detailed content.
3. Read the conclusions.
4. Skim through the references, mentally noting any that you are already familiar with.

By the end of the first pass, you should be able to answer the following five Cs:

1. **Category**: What type of paper is it — a measurement study, an analysis of an existing system, or a description of a research prototype?
2. **Context**: What related work is cited? What theoretical foundations does it build upon?
3. **Correctness**: Do the assumptions made in the paper seem reasonable?
4. **Contributions**: What are the key contributions of the paper?
5. **Clarity**: Is the paper clearly and effectively written?

After the first pass, you might decide not to read the paper further — either because it doesn't interest you, you lack the background to understand it, or the authors make flawed assumptions. A first pass is usually sufficient for papers outside your main research area but potentially useful later.

NOTE: When writing your own paper, remember that most reviewers and readers will likely only do a first pass. Therefore, it’s crucial to use clear, meaningful section headings and to write a concise, informative abstract. If the main ideas aren’t understandable within five minutes, the paper risks rejection or being ignored.

3.1.4.2 The second pass

In the second pass, read the paper more carefully, focusing on understanding the content while skipping detailed proofs. Take notes and mark important references for future reading. Pay close attention to figures and graphs, checking for proper labelling and statistical significance, as these details can reveal the quality of the work.

This pass should take up to an hour and should allow you to explain the main ideas and supporting evidence to someone else, even if the paper isn't directly in your research specialty. If you still don't fully understand the paper after the second pass—whether due to unfamiliarity with the topic, poor writing, or fatigue—you have three options: (a) set it aside, (b) revisit it later after gaining more background, or (c) push forward to a third, deeper pass.

3.1.4.3 The third pass

The third pass aims for a deep, thorough understanding of the paper, especially if you are reviewing it. You should try to mentally re-implement the work — recreating the study based on the authors' assumptions. Comparing your version to the actual paper helps reveal both its strengths and hidden weaknesses. This stage demands close attention to detail: question every assumption and consider how you might present the ideas differently. This critical analysis not only deepens your understanding but also improves your own research and presentation skills. You should also note ideas for potential future work.

NOTE: The third pass can take beginners around four to five hours, but experienced readers may complete it in about an hour. By the end, you should be able to reconstruct the paper's structure from memory and clearly identify its contributions, flaws, missing references, and any methodological issues.

3.2 Understanding a scientific article

Scientific articles can be quite complex, but they generally follow a common structure. Understanding the organization of this structure makes it easier to understand these articles.

3.2.1 Structure of scientific article (Original research article)

Most journals use a conventional IMRAD structure (table 3): An abstract followed by Introduction, Methods, Results, and Discussion. Each of these sections normally contains easily recognized conventional features, and if you read with an anticipation of these features, you will read an article more quickly and comprehend more.

3.2.2 How to understand an original research article?

3.2.2.1 The Introduction section:

Introductions serve to both engage readers and give them the background needed to understand the article. Typically, they begin with general information about what is already known on the topic, then narrow in on what remains unknown, eventually leading to the central question the authors aim to address. In doing so, authors summarize past research to establish the current understanding (the broad context) and then position their own study (the specific focus) within that framework. To understand the introduction, here's what you should focus on:

1. **Identify the research problem**: The introduction usually outlines a specific problem or question that the research addresses. Look for statements about what is not yet known or what needs to be solved.
2. **Understand the background context**: Authors summarize previous research to show what has already been discovered. Pay attention to key studies, theories, or gaps they mention.
3. **Spot the research gap**: The introduction highlights what's missing in existing knowledge. Authors often use phrases like "However, little is known about..." or "Previous studies have not addressed...".
4. **Note the research objectives or hypotheses**: Near the end of the introduction, you'll usually find a clear statement of what the researchers aim to do — sometimes framed as a hypothesis or specific goal.
5. **Look for key terms and definitions**: Authors may define important concepts early on. Understanding these is crucial for following the rest of the paper.

Tip: When reading, ask yourself:

- What issue is this article trying to solve?
- Why is it important?
- How does it build on or differ from past research?

Table 3: The structure of a primary research article.

Section	Content
Title	The "take home" message of the entire project, according to the authors.
Author list	These people made significant scientific contributions to the project. Fields differ in the standard practice for ordering authors. For example, as a general rule for biomedical sciences, the first author led the project's implementation, and the last author was the primary supervisor to the project.
Abstract	A brief overview of the research question, approach, results, and interpretation. This is the road map or elevator pitch for an article.
Introduction	Several paragraphs (or less) to present the research question and why it is important. A newcomer to the field should get a crash course in the field from this section.
Methods	What was done? How was it done? Ideally, one should be able to recreate a project by reading the methods. In reality, the methods are often overly condensed. Sometimes greater detail is provided within a "Supplemental" section available online (see below).
Results	What was found? Paragraphs often begin with a statement like this: "To do X, we used approach Y to measure Z." The results should be objective observations.
Figures, tables, legends, and captions	The data are presented in figures and tables. Legends and captions provide necessary information like abbreviations, summaries of methods, and clarifications.
Discussion	What do the results mean and how do they relate to previous findings in the literature? This is the perspective of the author(s) on the results and their ideas on what might be appropriate next steps. Often it may describe some (often not all!) strengths and limitations of the study: Pay attention to this self-reflection of the author(s) and consider whether you agree or would add to their ideas.
Conclusion	A brief summary of the implications of the results.
References	A list of previously published papers, datasets, or databases that were essential for the implementation of this project or interpretation of data. This section may be a valuable resource listing important papers within the field that are worth reading as well.

3.2.2.2 The Methods section:

The Methods section explains the experiments conducted to address the research question introduced earlier. It can be challenging to read (particularly for graduate students) due to its technical terminology and the detailed descriptions necessary for another trained scientist to replicate the work. However, by carefully reading this section, you can gain a clearer understanding of the experimental design and better assess the reliability of the results. To understand the methods section, here's what you should focus on:

1. **Identify the study design:** Determine whether the study is experimental, observational, qualitative, quantitative, or a combination. Understanding the design helps in assessing the appropriateness of the methods used.
2. **Examine the materials used:** Look for detailed descriptions of the materials, tools, or equipment employed in the study. This includes information about the source, quality, and specifications of these materials. Such details are essential for reproducibility.

3. **Understand the procedures:** Review the step-by-step processes undertaken during the research. This includes how data were collected, any interventions applied, and the duration and conditions of the study. Clarity in procedures ensures that the study can be replicated accurately.
4. **Assess the data analysis methods:** Pay attention to the statistical or analytical techniques used to interpret the data. Understanding these methods is key to evaluating the validity of the study's conclusions.
5. **Check for ethical considerations:** Ensure that the study mentions ethical approvals, consent procedures, and adherence to relevant guidelines, especially if human or animal subjects were involved.

Tips for effective understanding:

- **Pay attention to subheadings:** Labels such as "Participants," "Materials," "Procedure," and "Data Analysis" help organize the content and guide your focus.
- **Highlight important details:** Identify any unique approaches or modifications to standard methods.
- **Check referenced protocols:** When established methods are cited, reviewing them can offer valuable background and clarification.
- **Evaluate the level of detail:** Effective methods strike a balance—too little information makes replication difficult, while too much can bury the essential points.

3.2.2.3 The Results and Discussion sections:

The **results** section presents the findings of the study, often accompanied by visuals like figures and tables that illustrate the data. It focuses strictly on what was observed, without comparisons to other studies or broader interpretations. Such contextual analysis is reserved for the **discussion** section, where the authors interpret their results, relate them to existing research, and place their work within the larger field. The Discussion also aims to clearly address the research question introduced at the beginning of the paper.

To understand the results section, here’s what you should focus on:

1. Identify the research questions or hypotheses: Start by revisiting the research questions or hypotheses, usually outlined in the Introduction. This context is key to understanding the significance of the results presented.

2. Analyse the data presentation: Observe how the data is displayed—whether through narrative text, tables, or figures. Each format serves a specific role:

- **Text** provides a summary of the main findings.
- **Tables** offer exact numerical data.
- **Figures** help visualize patterns and trends.

3. Interpret statistical information: Pay close attention to statistical indicators like p-values, confidence intervals, and effect sizes. These values help determine the significance and reliability of the results.

4. Avoid drawing conclusions: Keep in mind that this section strictly reports the data. Any interpretations or discussions of meaning belong in the Discussion section.

Tips for better understanding:

- **Prioritize relevant data:** Focus on the findings that directly relate to the research questions.
- **Follow the order:** Results are often organized according to the sequence of the research questions or hypotheses.
- **Use visuals:** Refer to tables and figures to gain a clearer understanding of the data.
- **Stay neutral:** Avoid interpreting the results at this stage; concentrate on grasping what was observed.

To understand the discussion section, here's what you should focus on:

1. Highlight the main findings: Start by identifying the key results the authors focus on. This summary provides a foundation for understanding how they interpret their data.

2. Interpret results and explore implications: Pay attention to how the authors explain the significance of their findings in relation to the research question. They often describe how the results contribute to existing knowledge or challenge current theories.

3. Compare with previous research: Observe how the authors connect their findings to earlier studies. They may confirm, expand upon, or contradict previous work, placing their study within a broader scientific context.

4. Identify study limitations: Check if the authors acknowledge any limitations, such as small sample sizes or methodological weaknesses. This reflection indicates transparency and critical evaluation of their own work.

5. Note recommendations for future research: Look for suggestions on areas needing further investigation. These highlight gaps in knowledge and opportunities for future studies.

Tips for better understanding:

Watch for guiding phrases: Expressions like “Our results indicate...” or “This study reveals...” often point to key interpretations.

Separate data from interpretation: Make sure to distinguish between what was found (Results) and what the authors think it means (Discussion).

Think critically: Consider whether the conclusions are well-supported by the data and remain open to other possible interpretations.

4 Scientific terminology

4.1 Definition of terminology

Terminology is the discipline that deals with scientific or technical vocabularies. Its aim is to study the way in which sciences and techniques designate objects and phenomena. Terminology also refers to the identification, formatting and management of terms, particularly in the form of dictionaries and databases.

4.2 Origins of biological terminology

Precise biological terminology is fundamental for clear and effective communication in science, and it should be explicitly taught to students. To successfully learn Biology, students must be able to understand and use many complex and unfamiliar terms. Most of these terms are derived from Latin and Greek word components, which help convey specific meanings.

4.3 Word parts in biological terminology

Biological terms are often built from three main components:

- **Prefixes** (beginning part): is a group of letters placed before the root of a word (table 4).

Table 4: Prefixes examples.

Prefixes	Meaning	Example	Meaning of Example
a-, an-, non-,	Without, Not	Aphotic, Anaerobic, Nonrenewable	Without light, without air or oxygen, not able to replenish naturally
ab-, ef-	Away	Aboral, Efferent neuron	Away from the mouth, nerve cells going away from brain
ad-, af-	Toward	Adductor muscle, Afferent neuron	Muscle movement toward the body, nerve cells going toward the brain
adi-, lip-	Fat	Adipose, Liposuction	Fat tissue, Removing fat tissue
amphi-	Both sides	Amphibian	Both sides of land and water
ana-	Up	Anabolic	Build-up of larger molecules from smaller molecules
angio-	Vessel, Container	Angiosperm, Angiogram	Container for seed, Picture of a blood vessel
anti-, contra-	Opposite, Against	Anticodon, Contraception	Opposite of codon, Against conception
aqua-, hydr-	Water	Aquatic, Hydration	Of water, With water
arthro-	Joint	Arthropod, Arthritis	Jointed foot, Joint inflamation

- The **word root** is the core of many terms and refers to the body part or body system to which the term is referring (Table 5).

Table 6: Word root examples.

Word Root	Meaning	Example	Meaning of example
bio	Life	Biology	Study of life
cyt / cyto	Cell	Cytology	Study of cells
derm	Skin	Epidermis	Outer layer of the skin
cardi	Heart	Cardiology	Study of the heart
hemo / hemato	Blood	Hematology	Study of blood
neuro	Nerve	Neurology	Study of the nervous system
osteo	Bone	Osteoporosis	Condition of weak bones
myo	muscle	Myology	Study of muscles
gastr	stomach	Gastritis	Inflammation of the stomach
hepat	Liver	Hepatitis	Inflammation of the liver
nephr	Kidney	Nephrology	Study of kidneys
patho	disease	Pathology	Study of diseases
phyll	Leaf	Chlorophyll	Green pigment in plants
chlor	Green	Chloroplast	Green organelle in plant cells
arthr / arthro	joint	Arthritis	Inflammation of joints
phago	eat/swallow	Phagocyte	Cell that engulfs particles

- **Suffixes** (ending part): is a group of letters placed after the root of a word (table 6).

Table 7: Suffixes examples.

Suffixes	Meaning	Example	Meaning of Example
-cide	Kill	Herbacide, Insecticide	Plant killer, Insect killer
-cyte	Cell	Erythrocyte, Osteocyte	Red blood cell, Bone cell
-emia	Blood Condition	Hyperglycemia, Sickle cell anemia	High blood sugar levels, Sickle shaped red blood cells (should be circular)
-itis	Inflammation of	Dermatitis, Laryngitis	Inflammation of the skin, Inflammation of the larynx
-ase	Enzyme	Amylase, Lipase	Enzyme that breaks down carbohydrates, Enzyme that breaks down lipids
-osis	Condition/ process	Osmosis	Movement of water across a membrane
-plasm	Formation/ material	Cytoplasm	Substance inside the cell

4.4 Importance of biological terminology

The importance of biological terminology stems from its essential role in enabling clear, accurate, and universally understood communication within the field of Biology. Without a standardized vocabulary, explaining complex biological structures, processes, and interactions would become ambiguous and inconsistent.

1. **Precision and clarity**

Biological terminology ensures that scientists can describe organisms and biological processes with exactness. For instance, using a term like “mitochondrion” is far more precise than a general description such as “the part of the cell that produces energy,” thereby avoiding confusion and misinterpretation.

2. **Universal communication**

As a global discipline, biology depends on terminology that is widely recognized. Many biological terms originate from Latin and Greek, allowing scientists from different linguistic backgrounds to communicate effectively and collaborate without misunderstanding.

3. **Organization of knowledge**

Terminology plays a key role in structuring biological information. In areas such as Taxonomy and Systematics, consistent naming systems—like binomial nomenclature—help classify and organize living organisms in a logical and systematic manner.

4. **Efficiency in learning and teaching**

Standardized terms make it easier for students and researchers to understand and retain complex ideas. Words such as "photosynthesis" or "homeostasis" condense entire biological processes into single, meaningful terms, facilitating more efficient learning.

5. **Scientific accuracy and research**

Using precise terminology minimizes the risk of errors in scientific work. It ensures that experimental procedures, results, and interpretations are clearly communicated, reducing the likelihood of misinterpretation in research and clinical practice.

6. **Advancement of science**

Clear and consistent terminology supports the reproducibility of scientific studies and the effective sharing of knowledge. It allows discoveries to be accurately understood, validated, and expanded upon by the scientific community.

4.5 Some terms used in biology

A

Abiotic: Characteristic of non-living entities.

ABO blood groups: Antigens A and B found on red blood cells; based on genetic inheritance; O is the absence of both A and B antigens; possible phenotypes (i.e., blood types) include A, B, AB, and O.

Acquired immunity: Production of antibodies after exposure to antigens either naturally or through vaccination.

Active immunity: Self-produced immunity; antibodies produced based on exposure to antigens; may last long periods of time, even years; *See passive immunity.*

Active transport: Energy-requiring movement of materials across cell membranes; typically going against concentration gradients; *See passive transport.*

Adaptation: Genetic characteristics (morphological, physiological, or behavioral) that increase the survival and reproductive rates of organisms.

Adenosine triphosphate (ATP): Primary energy molecule in cells of all organisms; sometimes called the energy currency of a cell.

Adrenaline: Hormone from the adrenal medulla released during acute stress; also called *epinephrine.*

Algae: Photosynthetic, eukaryotic protists.

Alleles: Alternate phenotypes of genes.

Anatomy: Study of morphology.

Androgen: Steroid hormones affecting male reproduction and development.

Aneuploidy: Abnormal numbers of chromosomes.

Angiosperm: Plant that produces seeds inside a flower.

Antibiogram: analysis to determine the sensitivity of bacteria to antibiotics and to classify it as sensitive, resistant and intermediate.

Antibiotic: a substance of natural or synthetic origin, with the ability to stop the multiplication of bacteria.

Antibody (immunoglobulin): Proteins produced by white blood cells (B cells); important component of specific immunity; bind to antigens.

Anticodon: Triplet sequence of nucleotides on tRNA that allow for the complementary base pairing with mRNA during protein synthesis.

Antidiuretic hormone (ADH): Hypothalamic hormone that helps body retain water and increases blood pressure by increasing vasoconstriction; also known as vasopressin.

Antigen: Substance (biotic or abiotic) that triggers immune system to produce antibodies.

Antiparallel: Description of opposite direction of each side of the DNA molecule.

Apoptosis: Programmed cell death in tissues.

Arteriole: Blood vessel between arteries and capillaries.

Artery: Blood vessel transporting blood from the heart.

Asexual reproduction: Formation of new, genetically identical individuals from one individual via cell division or tissue budding.

Autoimmunity: The immune system attacks the organism's own cells or tissues.

Autonomic nervous system: Motor neurons that are typically under subconscious or automatic control, e.g., control of heart rate; *See somatic nervous system, sympathetic division, parasympathetic division.*

Autosome: Chromosomes not involved in sex determination.

Axon: Elongated extensions of neurons; important in transmitting nerve impulses.

B

B cell (B lymphocyte): A white blood cell that differentiates in the bone marrow; produces antibodies.

Bacteria: Prokaryotic domain; extremely prolific and diverse.

Bacteria: unicellular microorganisms without chlorophyll and visible only under the microscope. Bacteria are elements that do not belong to the plant or animal kingdom.

Bacteriophage (phage): Viruses specialized for bacteria.

Biochemistry: science that studies the correlation between the structure of natural molecules and the consequences on their activity.

Biology: The scientific study of life.

Biosphere: Collective habitats on Earth where life exists.

Biosynthesis: Anabolic reactions used to synthesize large, complex biological molecules, e.g., synthesis of proteins from amino acid precursors.

Biotechnology: Using organisms to produce products and advance technology.

Blastocyst: Embryonic blastula stage in mammals; implants in uterine lining in placental mammals.

Blastula: Embryonic developmental stage of animals characterized by a hollow ball of many cells.

Blood pressure: Hydrostatic pressure of blood inside blood vessels.

Blood: Fluid connective tissue with blood cells, e.g., *erythrocytes.*

Blood-brain barrier: Specialized blood vessels that inhibit transport of many substances into the brain; helps maintain homeostasis of brain fluids.

Bowman's capsule: Structure in vertebrate kidney that initially filters the blood; part of a nephron.

C

Cardiovascular system: The heart and circulatory system.

Carnivore: An organism that eats animals.

Cell cycle: Activity cycle of eukaryotic cells; includes interphase (G1, S, G2) and mitosis.

Cell differentiation: Morphological and functional specialization of cells in the various types of tissues of the organism.

Cell division: Cell reproduction; involves cytokinesis and typically mitosis.

Cell: Basic structural and functional unit of organisms.

Cell-mediated immunity: Acquired immunity involving identification of foreign or infected cells that are destroyed by cytotoxic white blood cells.

Central nervous system (CNS): The brain and spinal cord of most animals.

Centriole: Microtubular structures found in many eukaryotes; component of the centrosome.

Centromere: Connection region between chromatids of a duplicated chromosome.

Centrosome: Microtubule organizing center in eukaryotic cells.

Chiasma: Breakage and recombination point where chromatids of homologous chromosomes cross over.

Chlorophyll: Green photopigments used by photoautotrophs to synthesize food molecules.

Chloroplast: Plastid-containing chlorophylls and accessory pigments; used for photosynthesis

Cholesterol: Lipid compound used in cell membranes and precursors for steroid hormones, e.g., estrogen and testosterone.

Chromatin: DNA-protein complex found in eukaryotes; condition of DNA during interphase.

Chromosome: DNA-protein complex appearing as condensed chromosomes during mitosis and meiosis; can also refer informally to DNA-protein complex at any stage in the cell cycle.

Codon: Basic unit of the genetic code; consists of three nucleotides that code for amino acids to build proteins.

Collagen: Protein fibers found in connective tissues of animals.

Connective tissue: Supportive tissues in animals with relatively few cells embedded in a matrix.

Crossing over: Exchange of DNA portions between 2 homologous chromosomes: occurs during meiosis.

Cytology: (or cellular biology): an area of biology concerning the study of cells and their organelles, the vital processes taking place therein as well as the mechanisms allowing for their survival (reproduction, metabolism).

Cytoplasm: Contents inside a cell, except for the nucleus.

Cytosol: Fluid portion of the cytoplasm; contains many dissolved substances.

Deoxyribonucleic acid (DNA): Double helix, macromolecule involved in genetics and inheritance.

D

DNA ligase: Enzyme that attaches Okazaki fragments that were synthesized along the lagging strand of the DNA.

DNA polymerase: Enzyme that synthesizes new DNA by following the DNA base pairing rules of A with T and C with G.

Dominant allele: An allele that is expressed whenever present in a genotype.

Duplication: Chromosomal mutation resulting in the duplication of chromosomal fragments; occurs during crossing over.

E

Ecology: Relationships of organisms to their environment.

Ecosystem: Interacting unit of biotic communities and abiotic environments.

Ectoderm: Outer embryonic germ or tissue layer of an animal.

Egg (ovum): Female gamete.

Ejaculation: Release of sperm and semen from the male reproductive organs.

Embryo: Development of the zygote, eventually creating the adult individual.

Endocrine gland: Chemicals are released into the blood for distribution to target tissues throughout the body.

Endocytosis: Bringing materials into the cell interior.

Endoderm: Inner embryonic germ or tissue layer of an animal.

Endoplasmic reticulum (ER): Membranous organelles in eukaryotic cells; with attached ribosomes (rough ER or RER; makes proteins) or without ribosomes (smooth ER or SER; makes lipids, carbohydrates; detoxification).

Enzyme: a protein macromolecule which speeds up a biochemical reaction.

Enzyme: Biological catalysts; proteins and RNA (ribozymes).

Enzyme-substrate complex: Structure formed when substrate is held within the active site of the enzyme; initiates the chemical reaction.

Epidermis: Outer tissue layer of animals and nonwoody plants.

Erythrocyte: Red blood cells; transport gases (oxygen and carbon dioxide) in the circulatory system.

Estrogen: Steroid hormone class; important for female reproductive system and general growth.

Estrus: Reproductive sexual activity correlated to ovulation.

Evolution: Concept that all organisms are related to each other and have a common ancestor.

Excretion: Removal of nitrogenous waste materials by an animal.

Exocytosis: Exporting materials out of the cell.

F

Fermentation: Production of ATP without the use of an electron transport system; metabolic products are typically either ethanol or lactic acid, depending on the organism; form of substrate-level phosphorylation.

Fertilization: Fusion of gametes to form zygote; *See syngamy.*

Follicle-stimulating hormone (FSH): Pituitary hormone that stimulates egg production in females and sperm production in males.

G

Gamete: Haploid cells—egg and sperm—that combine (syngamy) during sexual reproduction, resulting in a diploid zygote.

Gametogenesis: Production of gametes.

Gastrula: Embryonic developmental stage characterized by an emerging tube or GI tract with one opening called the blastopore.

Gastrulation: Formation of the gastrula stage by invagination (i.e., inward growth) of the blastula.

Gene: Functional unit of heredity; nucleotide sequences in DNA or RNA (in certain viruses).

Genome: Complete genetic composition of a species.

Genotype: Specific alleles of a gene present in an individual.

Germ layers: Animal embryonic tissue layers; *See ectoderm, mesoderm, endoderm.*

Germinal tissue: Involved in production of gametes.

Gestation: Development of animal embryo inside the female (i.e., pregnancy in humans).

Glucagon: Hormone from pancreas that increases blood glucose levels; *See insulin.*

Glycogen: Animal starch; common in the liver and muscle cells.

Glycolysis: Initial step of cell respiration; glucose oxidized into 2 pyruvate molecules.

Golgi apparatus: Organelle in eukaryotes; packages and transports materials produced in endoplasmic reticulum; synthesizes carbohydrates.

Gonadotropin: Hormones that stimulate production in the ovaries and testes, e.g., follicle-stimulating hormone (FSH) and Luteinizing hormone (LH).

Gonads: Organs in animals that produce gametes.

Gram stain: Stains that can distinguish different species of prokaryotes, e.g., Gram-positive and Gram-negative.

Gram staining: staining which reveals the properties of the bacterial wall so that they can be used to distinguish and classify bacteria. The main distinction is between Gram-positive and Gram-negative bacteria.

Growth hormone (GH): Hormone from the pituitary that affects growth and development in many tissues.

Gymnosperm: Plant that produces seeds exposed on a modified leaf; does not produce a flower.

H

Haploid: Cell possessing 1 set of each type of chromosome.

Helper T cell: Enhances immune response by stimulating antibody and cell-mediated responses.

Hemoglobin: Iron-based respiratory pigment found in the blood of many animals.

High-density lipoprotein (HDL): Cholesterol transport molecule in the blood. Carries less Cholesterol than low-density lipoprotein (LDL).

Histology: the study of tissue in order to research tissue composition, structure and renewal and cellular exchanges within themselves.

Histone: Proteins important in eukaryotic chromosome structure; *See nucleosome.*

HIV (human immunodeficiency virus): Retrovirus that causes AIDS in humans.

HLA: the acronym of "Human Leukocyte Antigens": histocompatibility antigens whose role is essential in the tolerance of organ transplants and which are specific to a given individual.

Homeostasis: Process of maintaining constant conditions in an organism, e.g., temperature regulation.

Hormone: Chemical messenger that affects function, and is distributed within an individual via the blood or interstitial fluids.

Humoral immune response: Acquired immunity involving identification of foreign or infected cells that are destroyed by molecules in the blood, e.g., antibody reactions.

Hypothalamus: Inferior section of vertebrate brain; multiple functions, including homeostasis, hormone production, and regulation.

Hypotonic: Solution with a lower solute concentration than another solution (which is hypertonic.

I

Immunoglobulin (Ig): Proteins that form antibodies.

Innate immunity: Mechanisms of immune defense present prior to birth; does not require prior exposure; *See acquired immunity.*

Insulin: Hormone from pancreas that decreases blood glucose levels; also stimulates macromolecule synthesis.

Intron: Intervening sequences of Messenger RNA that are not expressed and must be removed; *See exons.*

Invertebrate: Animal without a vertebral column; most animals.

Isotonic: Solution with the same solute concentration of another solution.

L

Leydig cell: Testosterone-producing cells located between seminiferous tubules of testes.

Liver: Major organ in vertebrates with multiple functions, including detoxification of toxins in the blood and bile formation.

Locus: Specific location of a gene on a chromosome.

Low-density lipoprotein (LDL): Cholesterol transport molecule in the blood. Carries more cholesterol than high-density lipoprotein (HDL).

Luteinizing hormone (LH): Pituitary hormone that stimulates ovulation and formation of the corpus luteum in females, and Leydid cells in males to produce testosterone; also called interstitial cell stimulating hormone (ICSH) in males.

Lymphatic system: Vascular system with lymph nodes; returns excess fluids (lymph) from the blood, transports lipids from digestive tract to the blood, integral part of the immune system.

Lymphocyte: White blood cell involved in acquired immunity; *See B cells.*

Lysosome: Organelle that contains hydrolytic enzymes for intracellular digestion.

Lysozyme: Antibacterial enzyme produced in bodily secretions of animals.

M

Meiosis: Two-step cell division process that reduces the chromosome number (from diploid to haploid) and creates genetic variation.

Memory cell: Lymphocytes that retain the "memory" of previous exposure to an antigen resulting in a prolonged defense; *See vaccine.*

Menopause: When ovulation and menstruation cease.

Menstrual cycle: Periodic shedding of the uterine lining (endometrium) in the reproductive cycle of higher female primates in the absence of fertilization and implantation.

Mesoderm: Middle embryonic germ or tissue layer of an animal.

Messenger RNA (mRNA): Nucleic acid made from DNA sequence; used by ribosomes to synthesize proteins coded by genes.

Microbiology: study of microorganisms. In the field of in vitro diagnostics: culturing biological, food and pharmaceutical samples in growth medium allows any bacteria that may be present to multiply. The bacteria are subsequently identified and their susceptibility to antibiotics tested in certain cases.

Microorganism: a living organism of microscopic size.

Mitosis: Division and replication of the nuclear material (DNA) into two identical nuclei; cytokinesis typically occurs creating two identical cells.

Molecular biology: technique that can detect a bacterium, virus, yeast, parasite or a biomarker through the presence of DNA or RNA genetic sequences in a sample.

Morula: Embryonic developmental stage characterized by a solid ball of many cells.

N

Nephron: Structural unit of the vertebrate kidney.

Nerve: Bundle of nerve cells surrounded by connective tissue.

Nervous tissue: Neurons and supportive cells.

Neuron: Nerve cell; conducts electrical signals.

Nucleic acid: a naturally-occurring molecule found in each cell. It has the ability to hold and transmit coded hereditary instructions allowing for an organism's development. There are two types of nucleic acids: DNA and RNA.

Nucleoid: Dense area of DNA in prokaryotes; lacks nuclear membrane.

Nucleolus: Structure in nucleus for ribosome assembly.

Nucleosome: Structural unit of eukaryotic chromosomes consisting of two full loops of DNA around a histone core.

Nucleotide: Monomer units of nucleic acids; thymine, adenine, cytosine, guanine and uracil Nucleotides that code for amino acids to build proteins.

Nucleus: Membrane-bound organelle containing chromosomes.

P

Parasite: an organism that feeds off, lives or reproduces itself by establishing a lasting interaction with another organism (the host).

PCR (Polymerase Chain Reaction): molecular biology technology for in vitro amplification of genetic sequences, used to copy known DNA or RNA sequences in large quantities (by an order of magnitude of a billion) from an initially small quantity. This technology is particularly useful for detecting the presence of viruses.

Phagocytosis: Cells engulfing large particles; cell “eating”.

Pinocytosis: Cells engulfing dissolved particles; cell “drinking”.

Pituitary gland: Endocrine gland releasing many hormones from two major sections; anterior lobe (adenohypophysis) and posterior lobe (neurohypophysis).

Placenta: Structure that provides nutritional linkage between a fetus and the mother’s blood supply.

Plasma (cell) membrane: Selectively permeable membrane of all cellular life.

Plasma cell: Lymphocyte that produces antibodies.

Plasma: Liquid (water) portion of blood.

Plasmid: Small, circular DNA; accessory to chromosomes in prokaryotes and some yeasts.

Plastid: Three similar types of plant organelle: chloroplast, leucoplast (store starch) and chromoplast (have non-green pigments).

Platelet (thrombocyte): Found in blood; function in clotting.

Protein: a basic constituent of all living cells. A biological macromolecule is composed of one or more amino acid chains linked by peptide bonds.

R

Recessive allele: An allele that is not expressed when present with a dominant allele in a genotype.

Recombinant chromosome: Crossing over during meiosis can result in chromosomes with novel (i.e., different from either parental chromosomes) allele combinations.

Respiration: Gas exchange by organisms with the air or water to deliver oxygen to the tissues and expel CO2: *See cell respiration.*

Retrovirus: RNA virus that inserts its nucleic acid into the DNA of the host cell using an enzyme reverse transcriptase; *See transcription.*

Rh factor: Antigen found on the surface of red blood cells in some humans and other primates; Rh positive = present; Rh negative = absent.

Ribonucleic acid (RNA): Single-stranded macromolecule involved in transcription and translation of genes; multiple forms; genome of retroviruses.

Ribosomal RNA (rrna): Combine with proteins to form ribosomes.

Ribosome: Organelle responsible for protein synthesis during translation.

Ribozyme: RNA that has enzymatic function.

RNA polymerase: Enzyme that synthesizes new RNA by following the RNA base pairing rules of A with U and C with G.

S

Secretion: Releasing synthesized molecules to function elsewhere in the body or to be removed via excretion.

Seed: Plant embryo with a nutrient-filled tissue (cotyledon) enclosed in a protective seed coat.

Sperm: Male gamete; typically, motile to locate ovum (egg).

Spermatogenesis: Meiosis in animal males producing sperm.

Substrate: a molecule used as a starting product which binds to the active site of an enzyme and is converted into one or more products.

Symbiosis: Different species living together, or having a significant association.

Synapse: Gap between neurons, or neurons and muscles; *See neurotransmitter.*

T

Taxonomy: Classification and naming of organisms.

Testes: Male reproductive structure producing sperm and steroid hormones.

Testosterone: Steroid hormone class; important for male reproductive system and general growth.

Thyroid gland: Endocrine gland releasing hormones affecting body metabolism and bone development.

Tissue: Cells working collectively to perform specific functions.

Totipotent: Cells that have the ability to develop into any part of the organism.

Transcription: Synthesis of RNA based on the DNA template.

Transfer RNA (trna): Recognizes and transfers amino acids to ribosomes during translation.

Translation: Proteins are synthesized from mrna by ribosomes directing trna's to bring in the designated amino acids.

U

Urea: Water-soluble, nitrogenous waste product excreted by some animals; major waste component of urine.

Uric acid: Water-insoluble, nitrogenous waste product excreted by some animals, e.g., insects and reptiles (including birds).

Urinary bladder: Temporary storage pouch for urine.

Uterus: Female reproductive organ where fertilized eggs develop or are transported; mainly in mammals.

V

Vaccine: Non-disease-forming antigens of a pathogen are injected into the body to initiate an immune response so that protection will be present if the real pathogen is encountered; *See memory cell.*

Vagina: Structure in mammals used to receive the penis to facilitate delivery of sperm for fertilization.

Vertebrate: Chordate animals with a vertebral column; fishes, amphibians, reptiles (including birds), and mammals.

Virus: A submicroscopic infectious agent that is unable to grow or reproduce outside a host cell. It is non-cellular but consisting of a core of DNA or RNA surrounded by a protein coat.

Y

Yolk: Stored nutrients in an egg; used as an energy source by the developing embryo.

Z

Zygote: Fertilized egg; formed by syngamy.

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