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**Filière Sciences Biologiques**

**Département : Microbiologie / SBE/ BPC**

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**Module : Techniques de Communication et d'expression III**

# Chapter 02: Reading Comprehension

## *Part one: The scientific method*

## Introduction

What makes science scientific? What distinguish science from other disciplines? The term "Science" describes a process or the standards required of a process. Common sense invokes the same process of evidence and reasoning as scientists.

## 1. What is the scientific method ?

The Scientific Method is a process for asking and answering questions using a specific set of procedures. This process can be used as a guide to create comprehensive and meaningful science experiences for young children. Engaging children in scientific inquiry using all steps of the scientific method supports children to construct conceptually-related knowledge because at each step children use a variety of skills to discover new information about the concept of study (Gelman and Brenneman 2004).

## 2. Why should we follow a scientific method

The scientific method helps scientists gather facts to prove whether an idea is true. Using this method, scientists come up with idea s and then test those ones by observing facts. It even helps scientists check each other's work by following the same steps to see whether they get the same results to lead to better scientific evidence.

## 3. Steps of Scientific method

### Step 1: The Observation and Questioning

A scientist must define the question to be answered before beginning any inquiry. Observing some interesting natural events is a vital initial step in the scientific method. This observation ought to raise several inquiries on the phenomenon. This stage often calls for reviewing prior research on related topics and background information in order to comprehend the subject matter. Scientists can improve their research questions and more precisely fill in knowledge gaps by going over and analyzing prior studies. The formulation of a research question and the comprehension of pertinent previous research are crucial preliminary steps in the research process since they will impact the use of the scientific method.

***Prepared by : Dr OUARABI.L***

## Step 2: The Hypothesis

Developing a hypothesis based on past information is the next stage. An "uncertain explanation" or an unproven supposition that aims to explain a phenomenon using information gleaned from carrying out further tests or observations is called a hypothesis. To answer their questions, scientists typically create several hypotheses and conduct methodical testing on them.

For the scientific method to function, every hypothesis needs to fulfill a set of requirements. A hypothesis must first be verifiable and able to be tested. Although the premise may be true, this component is far more significant and vital. When a hypothesis can be verified by observations or tests and produces testable predictions, it is considered testable. A falsifiable hypothesis is one that can be disproven by observation of contradictory results. This enables researchers to build greater confidence over time by demonstrating that circumstances that could prove a hypothesis false do not arise, as opposed to gathering data proving a hypothesis is false.

## Step 3: Experimentation and Data Collection

Further observations or experiments that result in conclusions are needed to move forward. Scientists plan and carry out experiments to test their ideas after they are formulated. The data from these trials will either confirm or refute the hypothesis. Both qualitative and quantitative observations can be used to gather data. Observations that can be made just by using one's senses—whether they be taste, smell, touch, sound, or sight—are referred to as qualitative information.

Comparatively, quantitative observations are those in which a hypothesis is investigated using exact measurements of some kind. An experiment is a process used to ascertain whether real-world observations support or contradict the hypothesis's deduced predictions. When a hypothesis is supported by data from an experiment, it gains greater validity.

This does not prove the hypothesis is correct because additional research could find different aspects of the initial theory. Another crucial phase in the scientific method is experimental design, which has a significant impact on the findings and interpretations of an investigation. It is important to give experimental design and error minimization considerable thought and effort. Every variable or factor that could affect the experiment's outcome should be controlled by the researcher during its design. An experiment's conditions are described by two different kinds of variables: the independent variable and the dependent, or response, variable.

**Step 4: Results and Data Analysis**

Finding the meaning of the experiment's results is the next stage in the scientific method. To see if they can reject the null hypothesis, scientists compare the predictions made by their alternative hypothesis to those made by their null hypothesis. When the null hypothesis is rejected, it indicates that there is a considerable likelihood that the dependent variable's values in the control and experimental treatments differ from one another.

The alternative hypothesis can be accepted and the null hypothesis rejected if there are notable differences. On the other hand, if the null hypothesis is accepted, it means that the treatment has no bearing on the outcomes. Statistical tests are necessary to confirm the validity of the data and allow for further data interpretation before scientists can draw any conclusions about their null hypothesis based on their observations or experimental data. Researchers can use statistical tests to ascertain whether the control and experimental treatments really differ from one another. They can then produce tables and figures to support their conclusions.

**Step 5: Conclusions**

Giving explanations for the findings and any logical inferences that can be made from them constitutes the final step of the scientific method. This stage of the scientific method typically calls for a review of the literature and a comparison of the findings with those of other studies or observations on related subjects. This enables researchers to expound on the significance of specific results and place their experiment in a broader context. It also enables them to explain how their work fits into the discipline's broader context.

This is not the end of the scientific process! The scientific method operates over time as our understanding of specific mechanisms or processes that explain natural phenomena is shaped by the accumulation of knowledge on scientific subjects. If our null hypothesis is not rejected, we must go back to the beginning of the scientific method, try to rephrase our questions, and figure out why the expected result was not obtained.

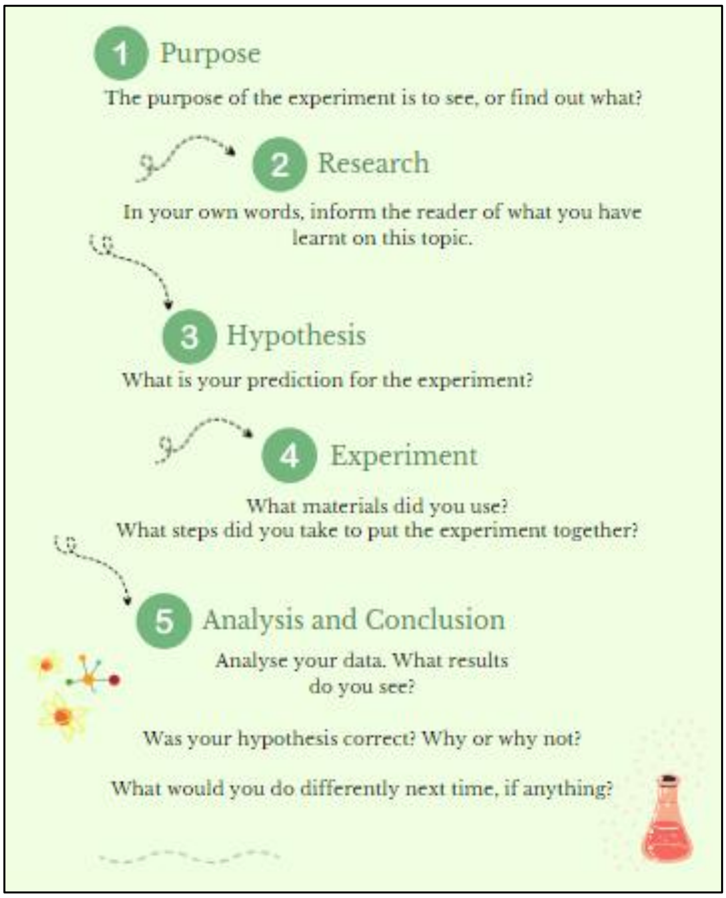



**Figure 01.** Steps of the scientific method

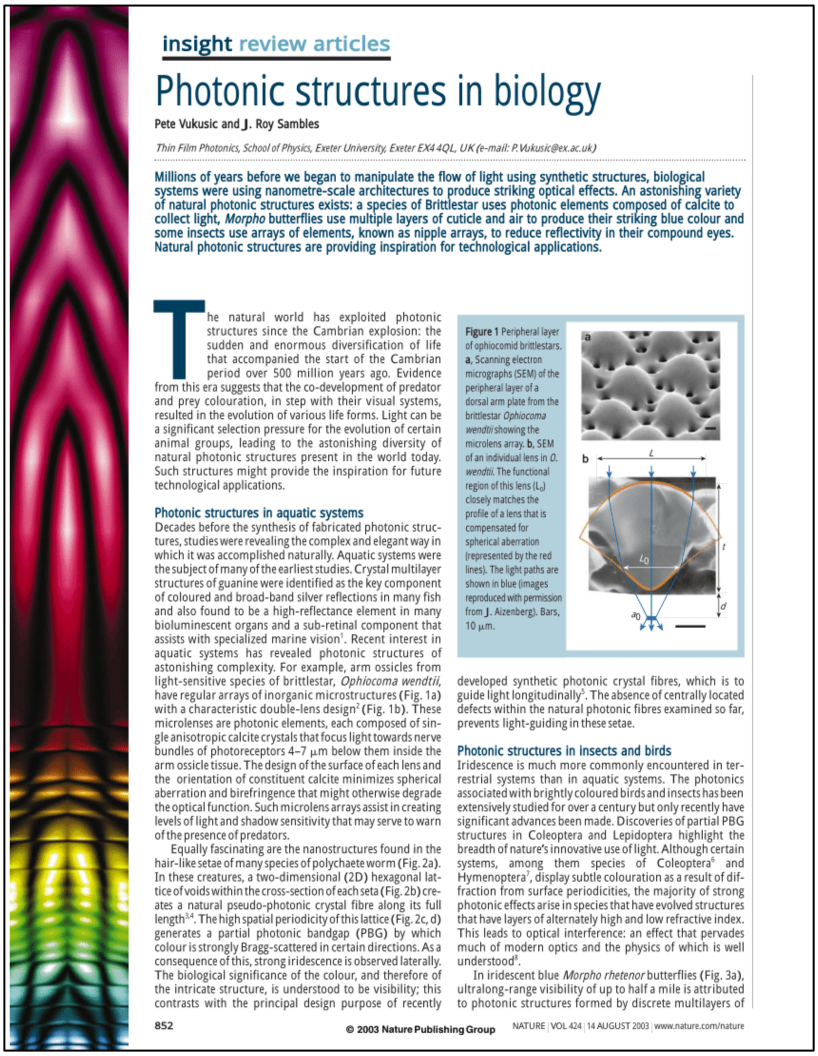
# *Part two: Scientific articles*

What makes a piece of writing scientific? Is it the topic, the method for gathering information, the writing style, the organization of the manuscript, or the peer-reviewing process? Could it be related to the type of publication? Actually, there are a wide variety of articles that fall under the scientific category. Nevertheless, before beginning the writing process, authors should have a thorough understanding of the many types of scientific articles and their subtleties. To maximize the reception of their research and increase their chances of publication, authors should ideally adapt their writing to the most suitable article category.

Scientific journals contain a wide variety of articles, each adding to the scope of the particular journal. Instructions to authors or author guidelines from journals typically contain specifics about the format, style, and goals of each kind of article. We will give a summary of the main categories of scientific articles in this chapter. Your mission is to assist young researchers, residents, and medical students in choosing the best format for sharing scientific information.

## 1. Review article

The importance of review articles in social and health sciences is increasing day by day. A review article surveys and summarizes priory published papers, rather than reporting new facts or investigation by primary data or empirical study. Review articles are, sometimes, called survey or overview articles. Academic publications that specialize in review papers are known as survey journals. The central and fundamental reason to writing a review item is to build a readable synthesis of the best resources available in the literature. Although the idea of writing a review is attractive, it is essential to employ time identifying the research questions. Good survey techniques are critical because they provide an unbiased point of view for the reader regarding the existing literature. A re-examination paper should be written a unanimity in a systematic manner. Review articles are divided into two categories as narrative, and systematic reviews. Narrative reviews are authored in an easily readable structure and allow the weight of subject matter within a large scale. However, in a systematic survey, a detailed and complete literature surveying is made on the selected topic. Systematic reviews are considered as gold standard articles as they contain lesser engagement of author's bias. Systematic surveys might be divided into qualitative, and quantitative reviews. Author should review 30-150 research papers to the preparation a review article a good systematic review need to more articles up to 150-whereas narrative one demands to overview 30-40 papers. 5,000 to 8,000 words are enough narrative and 6,000 to 12,000 words are good for systematic article. Systematic paper explores new scientific findings with accuracy, developing a new conceptual or theoretical or methodological approach. Whereas narrative one just analyze or synthesize or summarize a number of existing research studies.



insight review articles

# Photonic structures in biology

Pete Vukusic and J. Roy Sambles

*Thin Film Photonics, School of Physics, Exeter University, Exeter EX4 4QL, UK (e-mail: P.Vukusic@ex.ac.uk)*

**Millions of years before we began to manipulate the flow of light using synthetic structures, biological systems were using nanometre-scale architectures to produce striking optical effects. An astonishing variety of natural photonic structures exists: a species of Brittlestar uses photonic elements composed of calcite to collect light, *Morpho* butterflies use multiple layers of cuticle and air to produce their striking blue colour and some insects use arrays of elements, known as nipple arrays, to reduce reflectivity in their compound eyes. Natural photonic structures are providing inspiration for technological applications.**

The natural world has exploited photonic structures since the Cambrian explosion: the sudden and enormous diversification of life that accompanied the start of the Cambrian period over 500 million years ago. Evidence from this era suggests that the co-development of predator and prey colouration, in step with their visual systems, resulted in the evolution of various life forms. Light can be a significant selection pressure for the evolution of certain animal groups, leading to the astonishing diversity of natural photonic structures present in the world today. Such structures might provide the inspiration for future technological applications.

### Photonic structures in aquatic systems

Decades before the synthesis of fabricated photonic structures, studies were revealing the complex and elegant way in which it was accomplished naturally. Aquatic systems were the subject of many of the earliest studies. Crystal multilayer structures of guanine were identified as the key component of coloured and broad-band silver reflections in many fish and also found to be a high-reflectance element in many bioluminescent organs and a sub-retinal component that assists with specialized marine vision[1]. Recent interest in aquatic systems has revealed photonic structures of astonishing complexity. For example, arm ossicles from light-sensitive species of brittlestar, *Ophiocoma wendtii*, have regular arrays of inorganic microstructures (Fig. 1a) with a characteristic double-lens design[2] (Fig. 1b). These microlenses are photonic elements, each composed of single anisotropic calcite crystals that focus light towards nerve bundles of photoreceptors 4–7 μm below them inside the arm ossicle tissue. The design of the surface of each lens and the orientation of constituent calcite minimizes spherical aberration and birefringence that might otherwise degrade the optical function. Such microlens arrays assist in creating levels of light and shadow sensitivity that may serve to warn of the presence of predators.

Equally fascinating are the nanostructures found in the hair-like setae of many species of polychaete worm (Fig. 2a). In these creatures, a two-dimensional (2D) hexagonal lattice of voids within the cross-section of each seta (Fig. 2b) creates a natural pseudo-photonic crystal fibre along its full length[3,4]. The high spatial periodicity of this lattice (Fig. 2c, d) generates a partial photonic bandgap (PBG) by which colour is strongly Bragg-scattered in certain directions. As a consequence of this, strong iridescence is observed laterally. The biological significance of the colour, and therefore of the intricate structure, is understood to be visibility; this contrasts with the principal design purpose of recently developed synthetic photonic crystal fibres, which is to guide light longitudinally[5]. The absence of centrally located defects within the natural photonic fibres examined so far, prevents light-guiding in these setae.



**Figure 1** Peripheral layer of ophiocomid brittlestars. **a**, Scanning electron micrographs (SEM) of the peripheral layer of a dorsal arm plate from the brittlestar *Ophiocoma wendtii* showing the microlens array. **b**, SEM of an individual lens in *O. wendtii*. The functional region of this lens ($L_0$) closely matches the profile of a lens that is compensated for spherical aberration (represented by the red lines). The light paths are shown in blue (images reproduced with permission from J. Aizenberg). Bars, 10 μm.

### Photonic structures in insects and birds

Iridescence is much more commonly encountered in terrestrial systems than in aquatic systems. The photonics associated with brightly coloured birds and insects has been extensively studied for over a century but only recently have significant advances been made. Discoveries of partial PBG structures in Coleoptera and Lepidoptera highlight the breadth of nature's innovative use of light. Although certain systems, among them species of Coleoptera[6] and Hymenoptera[7], display subtle colouration as a result of diffraction from surface periodicities, the majority of strong photonic effects arise in species that have evolved structures that have layers of alternately high and low refractive index. This leads to optical interference: an effect that pervades much of modern optics and the physics of which is well understood[8].

In iridescent blue *Morpho rhetenor* butterflies (Fig. 3a), ultralong-range visibility of up to half a mile is attributed to photonic structures formed by discrete multilayers of

**Figure02.** Example of a review article

## 2. Original article

An original research article is an elaborate arrangement of study work written by the scientists based on primary resources. The original article is the valued most scientific work that offers the most valuable sources of academic literature. Some mentors may refer to these as scientific research papers or as empirical research. Empirical research project starting in or based on observation or experience research; capable of being examined or disproved by observation or experiment. Data derived from laboratory experiment or field interview with interview schedule or survey questionnaire. Such type of article can be conducted in quantitative, qualitative, or mixed method approach. Quantitative work done by numeric data collected using lab experiment or questionnaire survey and results would also be numeric. Again, qualitative one can be text data gathered from the field using interviews, observation, and group discussion. Their results will be produced in textual format producing a theory or concepts. This means a theory-based article is the representation of a qualitative paper. On the other hand, model, simulation, method, and methodological approach can be explored in the numeric article. An original article is less long than a review one. Generally, it consists of 5,000 to 10,000 words. Such type of work aims to test hypothesis in the eye of particular parameter as significant or not.

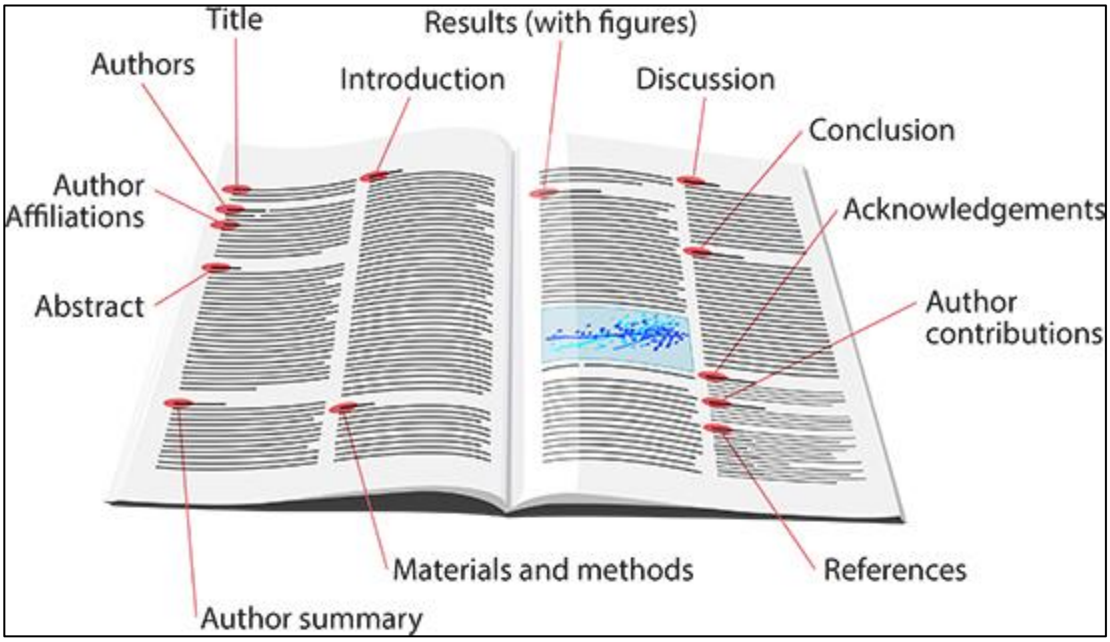



**Figure 03. Structure of a research article**

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