Eurasian Journal of Science and Environmental Education
2022, 2(1), 11-19
ISSN 2672-863X (Online)
https://www.ejsee.com/
Research Article
OPEN ACCESS

The Effect of Mind-Mapping on the Memorization and Acquisition of Immunology Concepts in the Secondary School

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Citation: Zghida, N. E., Janati-Idrissi, R., Rengasamy, R. P. M., & Sinan, O. (2022). The Effect of Mind-Mapping on the Memorization and Acquisition of Immunology Concepts in the Secondary School. *Eurasian Journal of Science and Environmental Education*, 2(1), 11-19. https://doi.org/10.30935/ejsee/12165

ABSTRACT

The majority of students do not want to learn with traditional methods and practices; they have found it difficult to recall knowledge presented in the classroom. Teaching and learning practices in secondary school do not facilitate the success of all students who have few opportunities to develop a good understanding and memorization of scientific concepts. In fact, teachers and researchers have the opportunity to identify and research alternatives to traditional practices. The aim of the current study is to highlight the impact of using mind-mapping on the memorization and acquisition of immunology concepts in secondary school and to evaluate its effectiveness as a teaching-learning practice. We assigned a quiz to 40 secondary school students in order to measure their memorization and acquisition, and used five mind-maps regarding the immunology concepts in the teaching process for the experimental group. We analyzed all the student's scores obtained in the quiz, and we found that the experimental group had a good understanding and memorization regarding immunology concepts and had more success than the control group in the quiz. However, we found that mind-mapping has a more important impact on the memorization and acquisition of immunology concepts in secondary school.

Keywords: acquisition, immunology, learning, memorization, mind-mapping

Received: 6 May 2022 ◆ Accepted: 10 Jun. 2022

INTRODUCTION

Improving the scientific achievement of 21st century learners requires new approaches to teaching science. In fact, teachers and researchers have the opportunity to identify and research alternatives to traditional practices. Current science teaching and learning practices in secondary school are inconsistent with what we know about how people learn; they do not facilitate the success of learners who have few opportunities to experience learning that promotes active participation and understanding (Bransford et al., 2000; Given, 2002; Wycoff, 1995). Learners rarely have the opportunity to construct meaningful learning strategies (Mayer, 1998). However, in science, they need to be exposed to teaching and learning practices that serve all learners in every classroom, as well as in their future learning (Ettinger, 1998, Longley et al., 2001; Texley & Wild, 1996).

Indeed, most middle school classes were centered on passive pedagogical practices in core subjects, including science (Jackson & Davis, 2000). Cawelti (1997) noted that secondary schools are still intended to feature lectures and passive learner presence. Teachers must provide the impetus for students to move from passivity to active engagement. This commitment will allow learners to integrate participation into their learning. We learn when we are actively focused on building our knowledge. This process helps to form the links between the prerequisites and the new knowledge. These connections can be stored and retrieved later (Mayer, 1998). Yet science students need to be exposed to teaching and learning practices that serve all learners in every classroom, as well as in their future learning.

For about thirty years, the pedagogy of biology has been developing, and trying to constitute itself as an autonomous discipline, generating its own specific concepts and allowing the elaboration of its own methods and strategies favoring adequate teaching-learning. The biology teacher assumes a certain number of pedagogical decisions to prepare a lesson or a sequence. In fact, it must specify the content and the pedagogical approach to be followed, as well as the needs and interests of the learners. Glickman (1991) asserts that:

> "effective teaching is not a set of generic practices; but also a series of decisions…"

So, the teacher must choose the strategies, the didactic methods, and techniques to maintain beneficial teaching according to the objectives of the topic addressed.

Currently, it is essential to think about rectifying and creating more innovative instructional methods that will motivate students to learn and allow them to overcome their difficulties in recalling the knowledge presented in the class (Buzan, 2000). Wandersee (1990) indicates the need to study the effects of using graphical representations in the field of science education. A tool that uses graphic representation is the mind-map, a graphic organizer, which spatially organizes information using key words, images, codes, symbols and colors. This type of organizer can address the visual-spatial intelligences of some learners (Gardner, 1985, 1999). By personalizing mind-maps, learners must interact with information that helps them make connections between their prior knowledge and the content being studied. It is these connections and the construction of knowledge that promote understanding (Buzan & Buzan, 1993; Fogarty & Bellanca, 1995; Margulies, 1991). Mind-maps are considered a quick and efficient method of taking notes and thus help to organize and visualize our thought processes (Buzan & Buzan, 1997; Lewis, 1997; Margulies, 1991; Wycoff, 1991, 1995).

Normally, it is recommended that teachers consider using the mind-map teaching approach to help learners enrich their understanding, especially for more complex or abstract science content (Dhindsa et al., 2011). Students do not want to learn with traditional methods and they have found it difficult to recall knowledge presented in class (Buzan, 2000). There is little research devoted to the effects of mind-maps on teaching and learning in the classroom.

Our study aims to measure the impact of the use of mind-mapping on the memorization and acquisition of immunology concepts and to evaluate their effectiveness as a teaching-learning technique and a powerful didactic support (**Appendix A**). The practice of these maps, using this particular graphic organizer, involves the spatial organization of information using key words, symbols, sketches and colors. The mind-mapping presents a framework for organizing ideas and concepts (Buzan & Buzan, 1993; Hyerle, 1996; Margulies, 1991; Wycoff, 1991). In this research, we are going to focus on the use of the mind-map in the classroom and what it can bring to high school students, specifically in the course of immunology, which contains a very rich vocabulary and diversified and complex scientific concepts. All this could be represented and synthesized in the mind-map, which has the role of highlighting the key words (scientific vocabulary) and the relationship between these terms.

Our research aims to answer the following questions:

1. How can we improve the understanding and acquisition of immunology concepts in secondary school?
2. Could mind-mapping help secondary school students to have good memorization of immunology concepts?

METHODOLOGY

Research Design

The research was conducted by quantitative research in order to measure secondary school students' memorization and acquisition regarding immunology concepts. The data were collected by administering a task individually to secondary school students aged between 14-16.

Sample and Data Collection

Our research was carried out face-to-face in the Annour School with students of the two classes of science subjects of the third year of middle school: 3/3 and 3/2, made up of a total of 48 students.

Analysis of Data

SPSS and Excel package programs were used in the data analysis related to the secondary school students' memorization and acquisition regarding immunology concepts. This software of descriptive statistics was used for calculating the average marks and mean scores of the study groups and to highlight the distribution of students' marks.

FINDINGS

Average and Distribution of Students' Scores

First of all, we will compare the general quiz scores obtained by the pupils of the experimental group and the control group. **Table 1** presents the general grades and the number of students as well as the class average for each group. These findings are based on heterogeneous samples of 48 students in total from two classes. Average scores are also shown. Sample quiz is shown in **Appendix B**.

Table 1. Average of students' scores

Number of students	Score/20
Experimental group	
3	14
2	15
4	15.25
3	15.75
2	18
2	19
3	19.25
2	19.5
2	19.75
1	20
Average	**17.10/20**
Control group	
2	4.75
3	6.25
2	7
3	8
4	9.75
2	13
2	14
1	15
3	16.75
2	17.5
Average	**10.81/20**

We found that all the students of the experimental group had a quiz score higher than the average 10/20, as well as the average class (17.10/20). We can say that the students understood the quiz exercises well and passed the test. For the control group, we found that 14 students out of 24 had marks lower than the average score (10/20). In fact, the class average was medium (10.81/20).

For the experimental group, we found that all students had a good score, while for the control group, more than 40% of students had scores lower than 10/20. From these results obtained, it can be seen that the control group had difficulties understanding and memorizing the immunology concepts; they were not able to answer the quiz questions correctly. On the other hand, the experimental group did well (**Figure 1**).

Figure 1. Distribution of students' scores

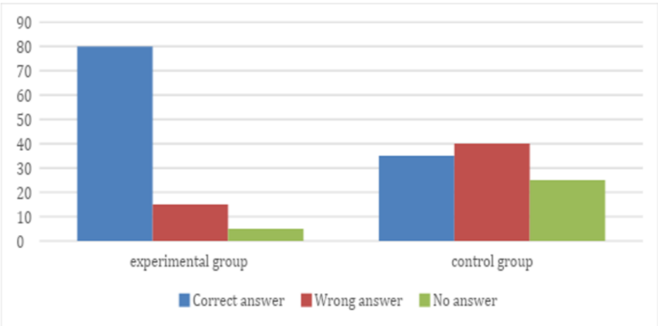

Figure 2. Comparing experimental and control group students' scores

Comparing Experimental and Control Group Students' Scores

In order to compare the results obtained, firstly, we will analyze students' responses, and secondly, we will compare and interpret them.

Test 1

The students of the experimental group responded well to the exercise with 80% correct answers. They had a good knowledge about the mechanism of the cell-mediated immune response (**Figure 2**).

The difference between the experimental and the control groups' scores is evident: the results concerning false answers and the absence of answers were respectively 13% and 4%. These negative outcomes are almost negligible in the experimental group, whereas the other group demonstrated 40% incorrect answers. This corresponds to the average of 10 students out of 24 who did not answer the questions correctly; most of them could not distinguish between the specific immune response and the non-specific one and could not give a correct definition of the phenomenon of phagocytosis.

Test 2

The control group students had difficulties in memorizing and acquiring immunology concepts. Regarding the results of the absence of responses, half of the control group did not respond to the exercise because the students likely did not remember the phases of the mechanism of the cell-mediated immune response (**Figure 3**).

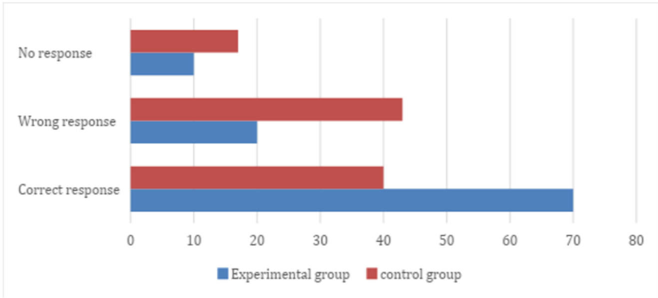

Figure 3. Comparison experimental and control groups students' scores

DISCUSSION

The mind-mapping was a powerful didactic tool for the experimental group who had high scores and did well understanding and memorizing different immunology concepts. On the other hand, the control group had enormous problems in terms of understanding and acquisition of the immunology course content; they were unable to distinguish between \different immunology concepts.

The mind-map represents a powerful graphic technique which aims to use the brain to its full capacity (Buzan & Buzan, 1993). Tellingly, studies point out that using the mind-mapping technique develops thinking skills. According to Mona and Adbkhalick (2008), mind-mapping is important, effective, and useful for learners to structure their understanding of concepts in ways that help them to be effective in the classroom. In addition, these learners can better explain concepts that mere words cannot describe. Mind-maps are student-centered, they encourage teacher-learner interaction, and they help students retain information longer. In addition, the research on active and collaborative learning techniques as well as various learning styles suggests that mind-mapping is an effective way to meet learners' needs (Budd, 2004).

According to Buzan (2005), mind-mapping is used in learning because it is a quick and efficient technique for taking notes and helping to organize and visualize thought processes.

In fact, mind-mapping is a useful approach that helps learners learn more effectively, improves the way they record information, and supports and enhances their creative problem solving. Therefore, teachers should adopt it as a method of learning. Also, the mind-map helps learners remember information because they retain it in a format that the mind finds easy to recall and review quickly. It also helps students improve their innovative and creative thinking (Adodo, 2013).

Teaching the natural sciences today, in our opinion, can no longer be done without taking into account the extraordinary potential of mental maps, provided that these are integrated in a relevant way into the curriculum. Not only do mind-maps help create metacognitive connections in the learner, but they also have an advantageous role in evolution of conceptions and thus in process of developing knowledge.

CONCLUSION

This research allowed us to highlight the positive effects of mind-mapping on the improvement of learning in the immunology course. Indeed, a drastic improvement in the quality of student learning was noted, as was the great help mind-mapping provided to students in organizing their knowledge in a hierarchical and logical way. The construction of a mind-map must take into account the functioning of our brain, by associating with each key word key images which have a meaning for the learner and which will allow him to establish links between the different branches of the mental map. In fact, it is by promoting this association that students will be able to develop the mental images necessary for long-term memorization.

However, we can conclude that the initial hypotheses are confirmed. The mind-map is therefore a tool that should be utilized because it has a positive effect on improving the learning and memorization of science, and more specifically, scientific subjects' rich in vocabulary such as immunology. This will yield improvements in academic success through a different approach to traditional learning techniques.

In this research, we have shown that there are other options for the development of learners' work in science. Each teacher should introduce different teaching strategies in the classroom. With these new strategies, learners can learn more effectively, and the more they use these methods, the better their levels of science knowledge and skills will be.

The mind-map is therefore an important pedagogical tool that can be integrated into the teaching-learning process because it could help some students' progress by offering them a clearer vision of information that ensures better memorization of ideas and scientific terms and especially those in the world of immunology which seem difficult for them.

Recommendations

The mind-mapping can be a powerful didactic tool in the teaching of sciences and effective as a teaching-learning practice. According to Buzan (2000), learners do not want to learn with traditional practices. In this sense, it is recommended that teachers consider using the mind-map as a pedagogical tool helping students to enrich their understanding, especially for more complex scientific content.

Limitations

Our study has some limitations, as follows:

1. Due to COVID-19 situation, we could get a more sufficient sample size for statistical measurements and
2. Lack of previous research studies on the topic.

Author contributions: All authors were involved in concept, design, collection of data, interpretation, writing, and critically revising the article. All authors approve final version of the article.

Funding: The authors received no financial support for the research and/or authorship of this article.

Declaration of interest: Authors declare no competing interest.

Data availability: Data generated or analyzed during this study are available from the authors on request.

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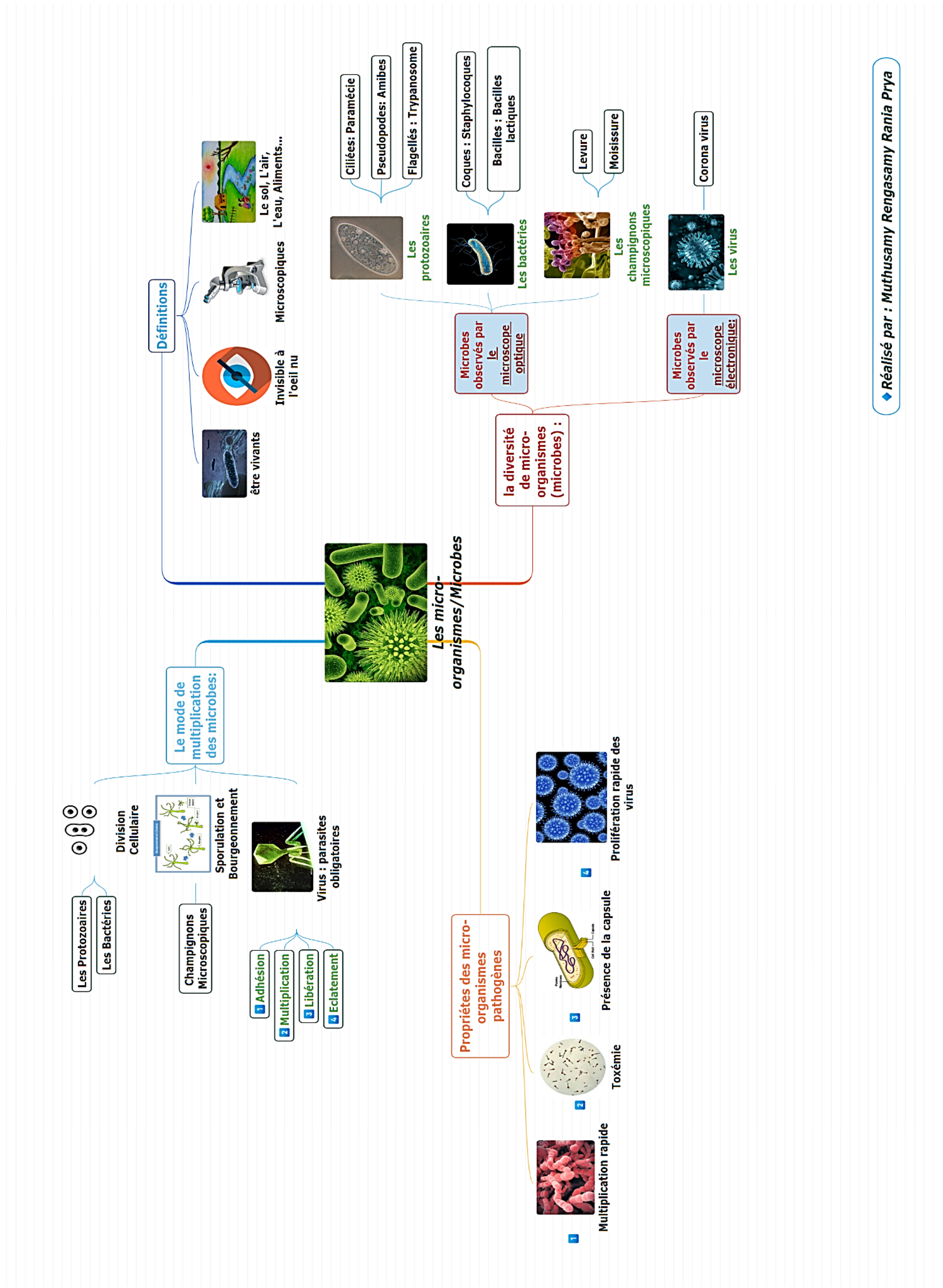
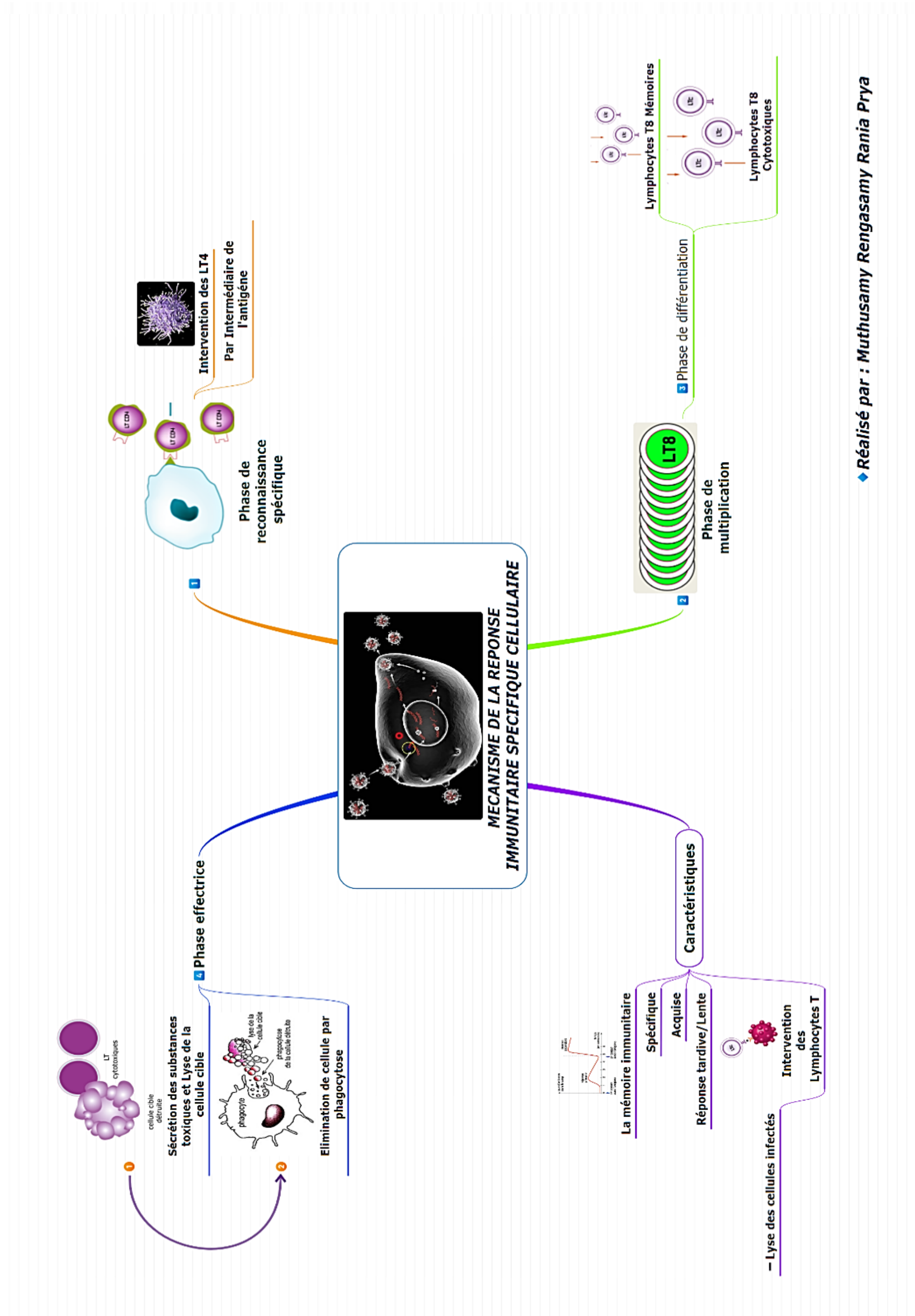
APPENDIX A: MIND-MAPS

Micro-Organisms Mind-Map

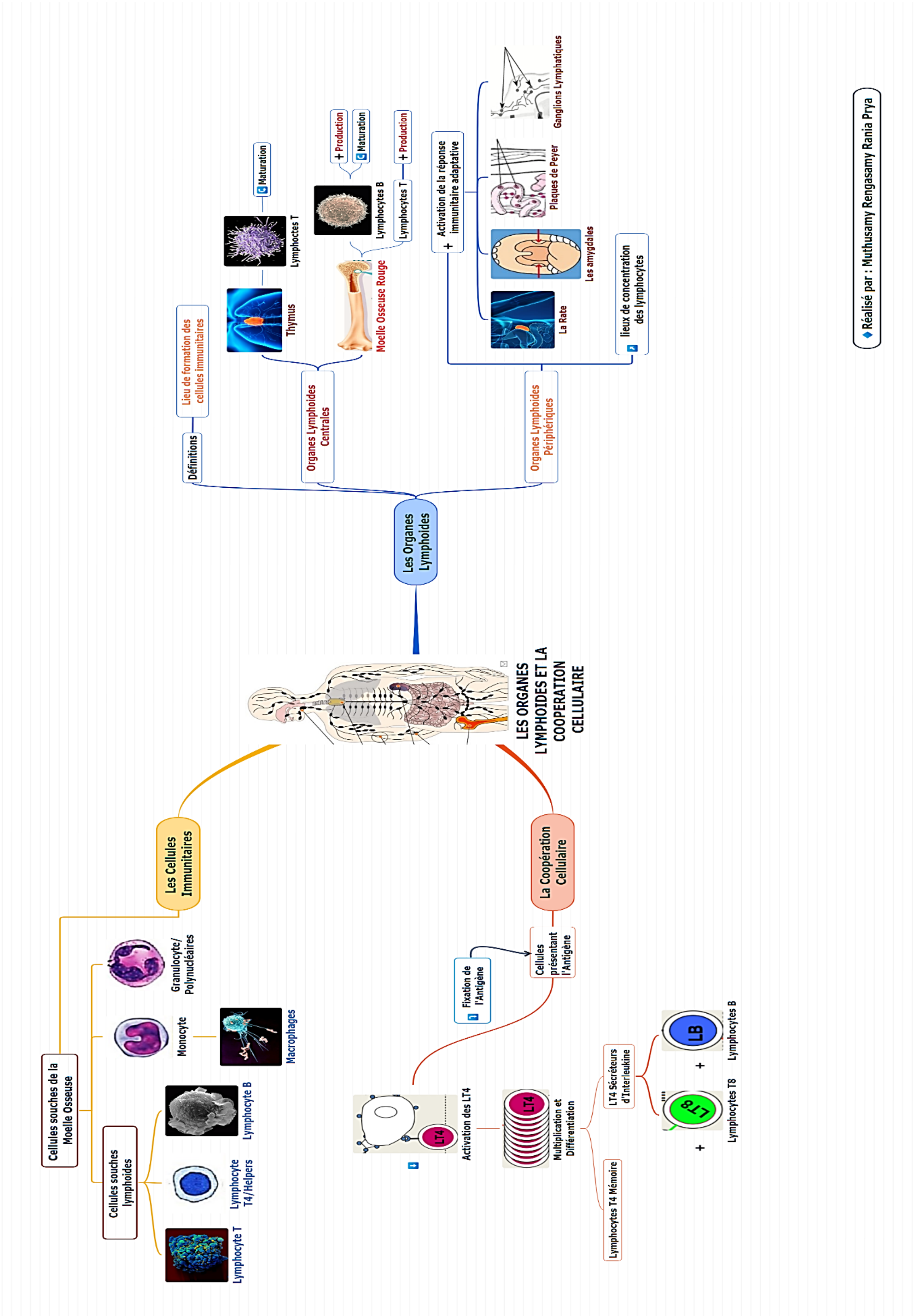


Non-Specific Immune Response Mind-Map



Cell-Mediated Immune Response Mechanism Mind-Map

Cellular Cooperation Mind-Map



APPENDIX B: QUIZ (in French)

I. Pour chaque question, il vous est donné quatre propositions A, B, C, et D. Répondez en entourant la proposition exacte (5 points).

QUESTION N° 1

Les micro-organismes:

A. sont observables à l'œil nu

B. sont tous des bactéries

C. sont tous pathogènes

D. sont microscopiques

QUESTION N° 2

La réponse inflammatoire:

A. est une réaction immunitaire lente et spécifique

B. caractérisée par une mémoire immunitaire

C. elle s'installe au niveau d'une lésion ou plaie

D. caractérisée par les quatre symptômes suivants: Rougeur, Chaleur locale, Gonflement et digestion

QUESTION N° 3

Un Anticorps:

A. est une protéine produite par un monocyte

B. est une molécule produite par un micro-organisme

C. est capable de neutraliser un antigène

D. capable de favoriser la phagocytose

QUESTION N° 4

Les organes lymphoïdes centrales sont composés de:

A. la rate, plaques de Peyer et les amygdales

B. le thymus, ganglions lymphatiques

C. la moelle osseuse rouge et le thymus

D. aucune réponse n'est exacte

QUESTION N° 5

Lorsqu'un lymphocyte B reconnaît un antigène:

A. il se multiplie pour former des lymphocytes mémoire et des plasmocytes,

B. il se multiplie pour former des lymphocytes mémoire et des lymphocytes cytotoxiques,

C. il se multiplie pour former des leucocytes polynucléaires,

D. une réponse immunitaire spécifique cellulaire se déclenche.

II. Répondez par vrai ou faux (5 points):

1. Les protozoaires, les champignons microscopiques et les virus peuvent être observés par le microscope optique: ....
2. Les lymphocytes T4 sont des lymphocytes T auxiliaires qui jouent un rôle essentiel_dans les réponses immunitaires, en sécrétant des substances chimiques nécessaire à l'activation des autres cellules immunitaires: ....
3. Des phagocytes comme les polynucléaires interviennent directement pour éliminer l'antigène; c'est la réponse immunitaire spécifique (acquise): ....
4. Anatoxine: une toxine qui a perdu sa toxicité, mais qui garde son pouvoir immunogène: ....
5. Les barrières chimiques agissent par l'acidité de milieu ou par les enzymes qu'elles contiennent pour empêcher la multiplication et la pénétration des bactéries dans l'organisme: ....

III. Nommer les étapes de la phagocytose et définir le phénomène (5 points):

A. ....

B. ....

C. ....

D. ....

2. Définition: ………

3. Il s'agit de quel type de réponse immunitaire?

……

IV. Citer les phases du mécanisme de la réponse immunitaire spécifique cellulaire (5 points):

Phase 1: ....

Phase 2: ....

Phase 3: ....

Phase 4: ....

Nommer les étapes suivantes et définir le phénomène: (5 points)

A.…………………….. **B.……………………..** **C ……………………..** **D.……………………..**

1. Définition: ………
2. Il s'agit de quel type de réponse immunitaire?

……

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