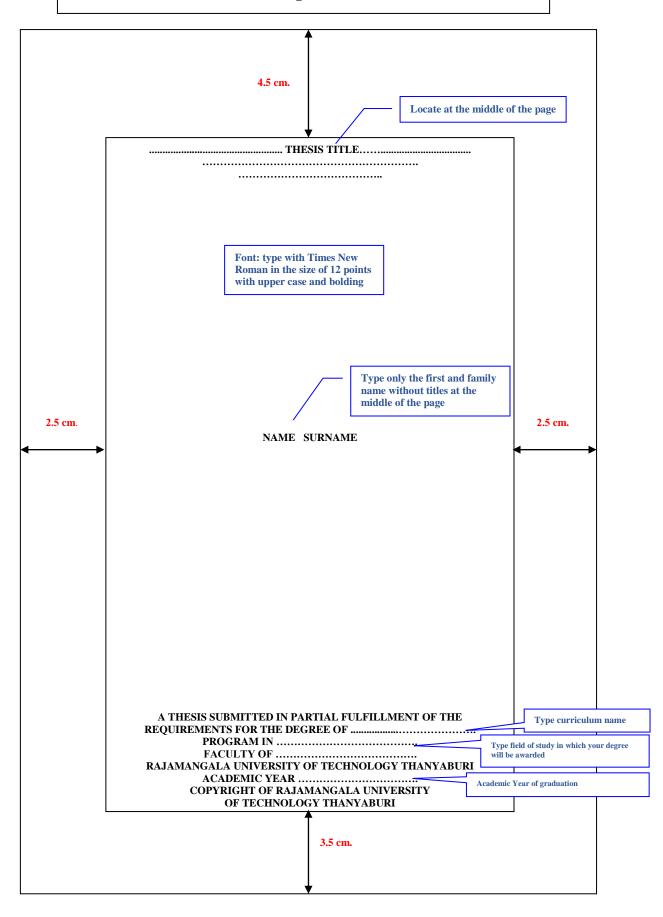
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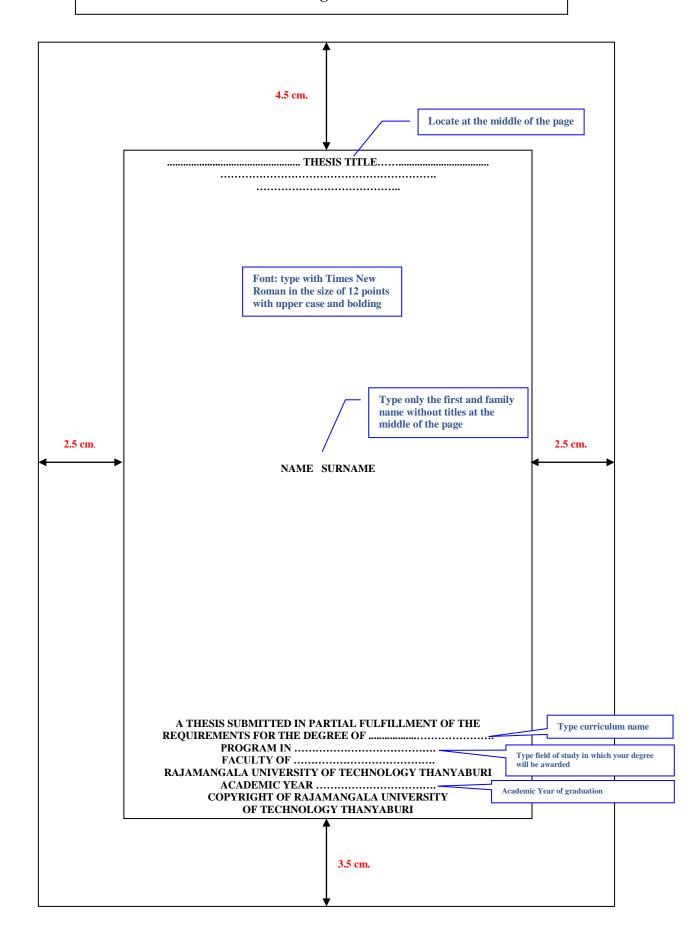
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UTILIZATION OF ORGANIC BANANA PEEL EXTRACT FOR ENHANCING IMMUNE RESPONSE OF GIANT FRESHWATER PRAWN (MACROBRACHIUM ROSENBERGII)

THANYARAT NAKSING

A THESIS SUBMITTED IN PARTIAL FULLFILLMENT OF THE
REQUIREMENT FOR THE DEGREE OF MASTER OF SCIENCE
PROGRAM IN APPLIED BIOLOGY
FACULTY OF SCIENCE AND TECHNOLOGY
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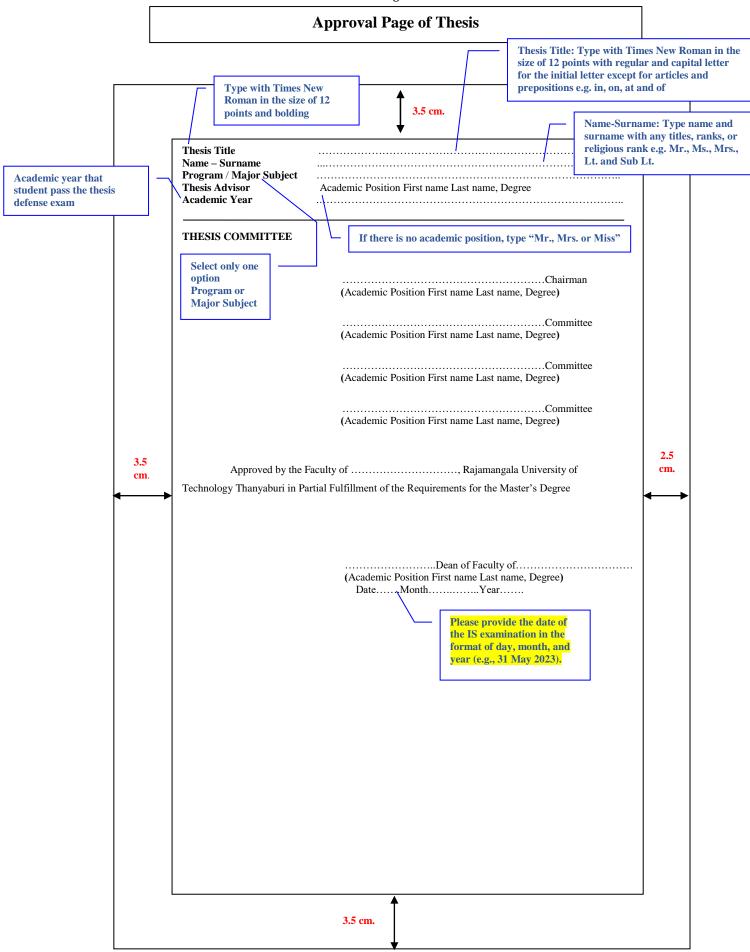
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Program Applied Biology

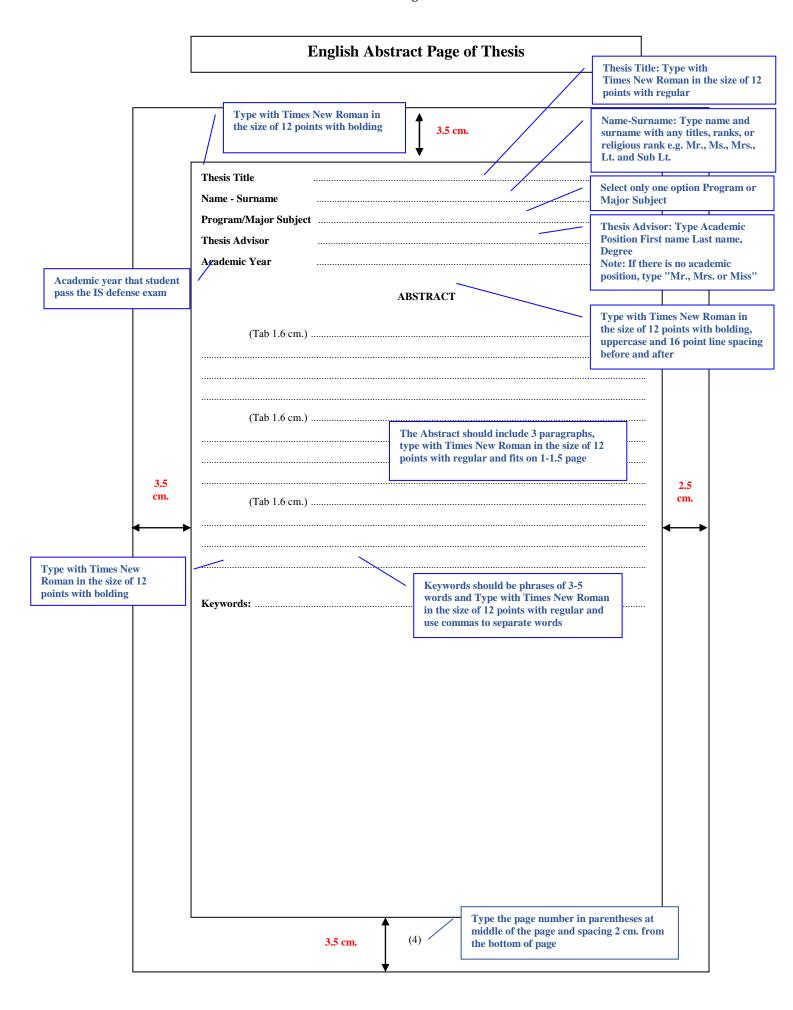
Thesis Advisor Mr. Atsadawut Areesirisuk, Ph.D.

Academic Year 2020

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Name-Surname Miss Thanyarat Naksing

Program Applied Biology

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ABSTRACT

This research aimed to: (1) study the bioactive compound properties and specify the phytochemical constituents of organic banana peel extract (BPE) from six types of organic banana cultivars, including Kluai Homthong, Kluai Namwa, Kluai Kai, Kluai Hukmook, Kluai Lebmuernang, and Kluai Homtaiwan, (2) optimize the optimum extraction condition, and (3) investigate the effect of organic BPE injection and the use of organic BPE as a dietary supplement to immunity of giant freshwater prawn (*Macrobrachium rosenbergii*).

Firstly, the biological activities of organic BPE, i.e., total phenolic content (TPC), antioxidant content, and ferric-reducing antioxidant power (FRAP) were measured. The result was found that the organic BPE of Kluai Kai provided the highest TPC and FRAP. Organic BPE of Kluai Hukmook could inhibit Aeromonas hydrophila and Staphylococcus aureus. The Fourier-transform infrared spectroscopy (FTIR) spectrum exposed diverse compounds of primary and secondary phytochemical compounds. Four main constituents which were determined by gas chromatographymass spectrometer (GC-MS) were acetic acid, formic acid, 1, 2-benzenediol, 3-methyl-, and 4-hydroxy-2-methylacetophone. The compounds exhibited antioxidant properties and antipathogenic activity. The BPE of Kluai Homthong could inhibit aquatic pathogen A. hydrophila and provided the highest extraction yield. Thereby, banana peel (BP) of Kluai Homthong was chosen to study the optimum extracting condition. The next experiment was to study the optimum extracting condition of organic BPE. The optimum extracting condition was 50 % v/v of methanol solution at 100 °C for 10 minutes. Under this condition, the maximum TPC and extraction yield were provided for 10.44 mg equivalent of gallic acid per gram of dried material (mg GAE / g DM) and 33 % w/v, respectively. This organic BPE was also able to inhibit *A. hydrophila* at a minimum inhibitory concentration (MIC) of 312.50 µg/disc. Finally, the effects of organic BPE on the immunity of *M. rosenbergii* were investigated by directly injecting the extract and supplementation of the extract in a cultured diet. The result presented that the direct injection of organic BPE could increase immunity and phagocytic activity and decrease the susceptibility of *M. rosenbergii*. In addition, the diet supplemented with organic BPE and probiotic powder could also enhance the immune system, reduce the coagulation time of *M. rosenbergii*, and increase resistance to pathogen *A. hydrophila* after 90 days of feeding.

Overall findings have shown that organic BPE was an interesting supplement for enhancing the immunity of giant freshwater prawn and resistance against *A. hydrophila*. Furthermore, the use of banana peel (BP) in aquaculture could increase the value of BP and reduce the burden of its waste disposal in the environment.

Keywords: organic banana peel extract, biological activity, giant freshwater prawn (*Macrobrachium rosenbergii*), immunity

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Acknowledgements

For this thesis, first of all, I would like to express my deepest gratitude to my advisor Dr. Atsadawut Areesirisuk for their brilliant instruction, encouragement, guidance, and always support throughout this thesis; without their kindness, this work could not be accomplished.

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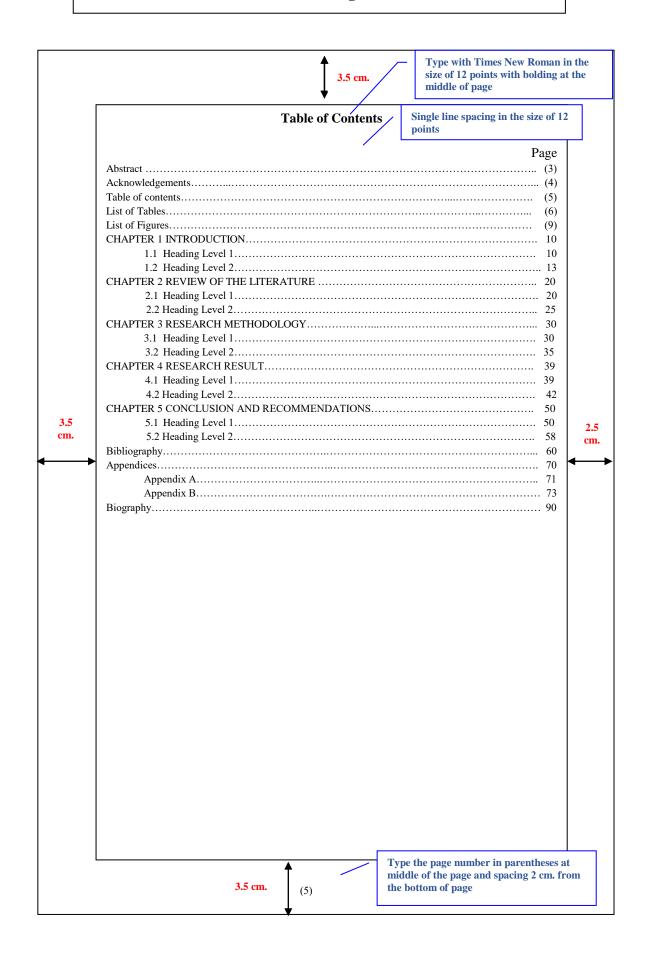
Third, I would like to thank also extended to Asst. Prof. Dr. Ratchaneegorn Mapanao and Asst. Prof. Dr. Nopparat Buddhakala for serving as a thesis president and committee, comment, and also suggestion.

Also, I would especially like to thank my committee members, Bioengineering Lab (ST-1 4 0 8), sisters and staff in Division of Biology, Faculty of Science and Technology, RMUTT and Department of Fisheries Technology, Faculty of Agricultural Technology, KSU, who always supported me throughout my study and experiment. Without their support this dissertation would not have been achievable.

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Thanyarat Naksing

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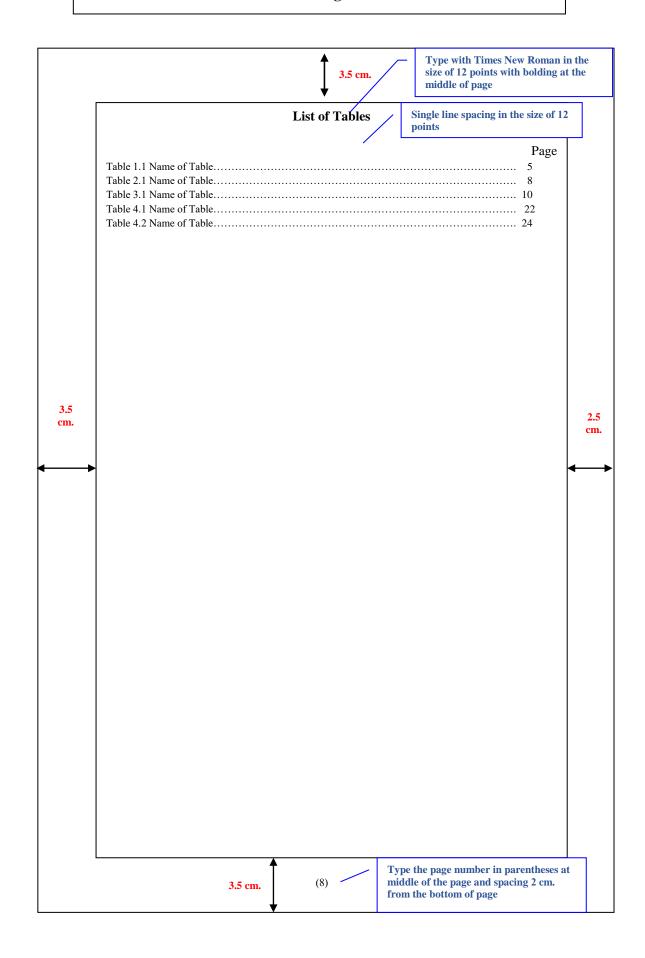
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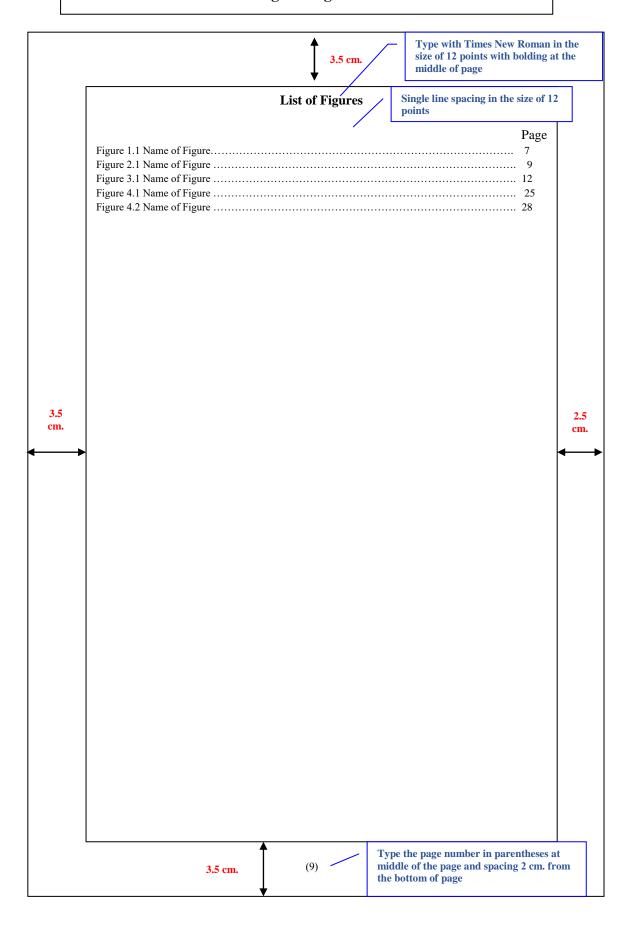


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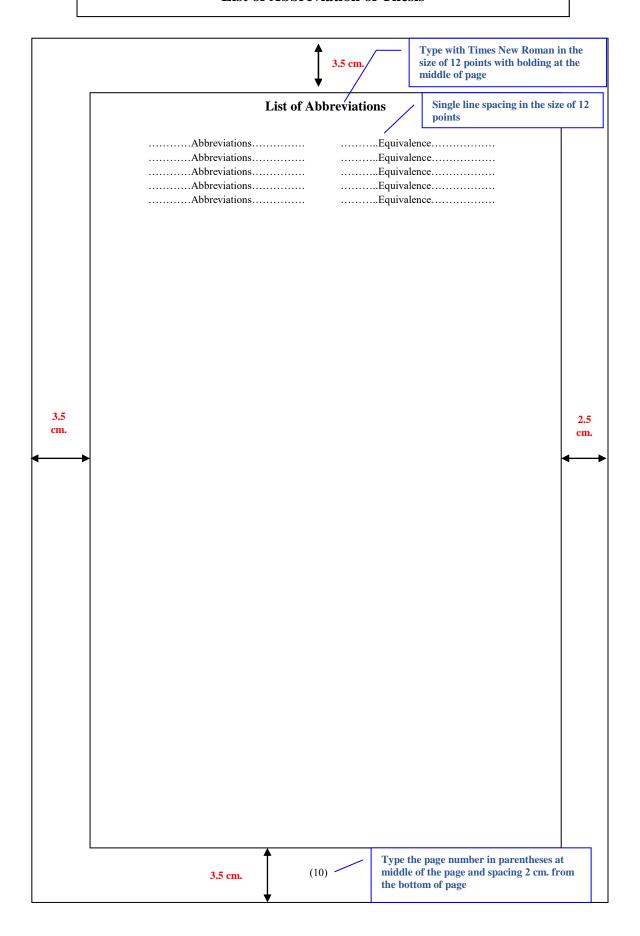


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List of Abbreviation of Thesis



Example of List of Abbreviation of Thesis

List of Abbreviations

ADPCM Adaptive Different Pulse Code Modulation

ANN Artificial Neural Network

CPU Central Processing Units

DMR Digital Mobile Radio

DSP Digital Signal Processing

FFT Fast Fourier Transform

FS1016 Federal Standard 1016

IP Internet Protocol

ITU-T International Telecommunications Union-Telecommunications

KBPS Kilo Bits Per Second

KSOFM Kohonen Self-organizing Feature Maps

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CHAPTER 1 INTRODUCTION

In modules and rings theory research field, there are three methods for doing the research. Firstly, to study about the fundamental of algebra and modules theory over arbitrary rings. Secondly, to study about the modules over special rings. Thirdly, to study about ring R by way of the categories of R-modules. Many mathematicians have concentrated on these methods.

1.1 Background and Statement of the Problems

1.2 Purpose of the Study

In this thesis, we have the purposes of study which are to extend concept of the previous works and to generalize new concepts which are:

- 1.2.1 To extend the concept of mininjective modules.
- 1.2.2 To generalize the concept of small principally quasi-injective modules.
- 1.2.3 To establish and extend some new concepts which are dual to small principally quasi-injective modules [18] and quasi-small principally-injective modules [19].

1.3 Research Questions and Hypothesis

We are interested in seeing to extend the characterizations and properties which remain valid from these previous concepts which can be extended from principally injective modules [2], principally-injective rings [7], mininjective modules [8], principally quasi-injective modules [9], small principally quasi-injective modules [18] and quasi-small principally-injective modules [19].

In this research, we introduce the definition of small simple quasi-injective modules and

1.4 Theoretical Perspective

In this thesis, we use many of the fundamental theories which are concerned to the rings and modules research. By the concerned theories are :

- 1.4.1 The fundamental of algebra theories.
- 1.4.2 The basic properties of rings and modules theory.

1.5 Delimitations and Limitations of the Study

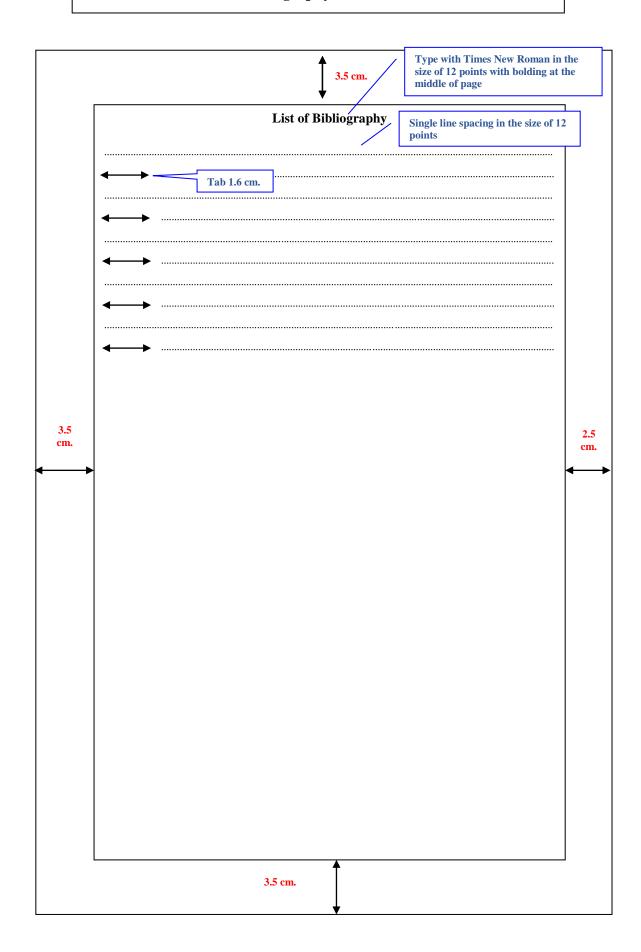
For this thesis, we have the scopes and the limitations of studying which are concerned to the previous works which are:

- 1.5.1 To extend the concept of mininjective modules.
- 1.5.2 To extend the concept of small principally quasi-injective modules and quai-small P-injective modules.
 - 1.5.3 To characterize the concept in 1.5.2 and find some new properties.

1.6 Significance of the Study

The advantage of education and studying in this research, we can improve and develop the concepts and knowledge in the algebra and modules research field.

Bibliography of Thesis



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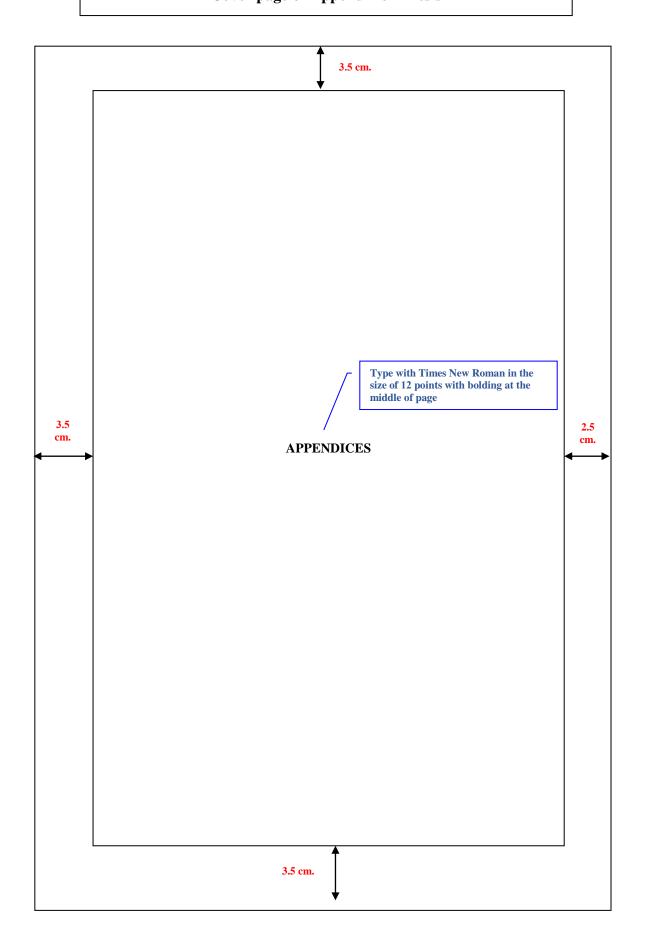
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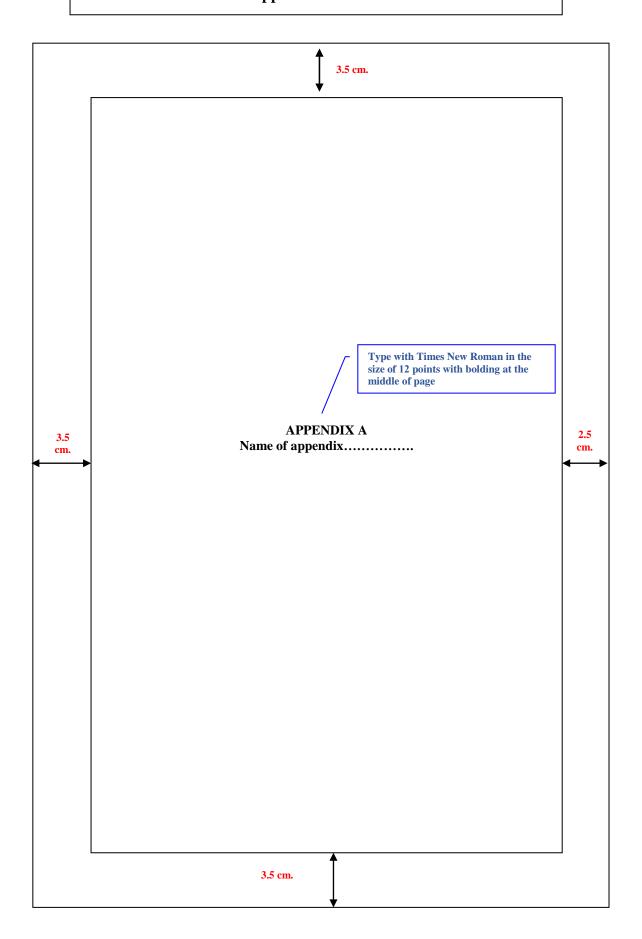
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APPENDICES

Appendix of Thesis



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APPENDIX A

Reagents for Preparation of Metacercariae

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Biography

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