〔大学院総合医薬学研究科総合医薬学専攻博士後期課程先端薬科学プログラム〕（外国人留学生特別入試）（第２回）

小論文・適性検査（Short Essay and Aptitude Test）　　受験番号（Examinee's No.）

分野名（Educational area）Medicinal Resource Science　　氏 名（Name）

（裏面にわたる場合は，この線より下に解答すること。）
（If your answer is longer than the space provided, you can write on the back of this page, but please write below this line.）

Q Describe the research you intend to pursue in your doctoral program, addressing the following five points. Please include hand-drawn diagrams, sketches, or flowcharts to make your explanation clearer. You may use both sides of the paper if needed.

1. Objective
2. Background
3. Goal
4. Methods
5. Significance

【出題の意図（Intention of the question）】
自らが取り組もうとする研究課題についてどれだけ深く考えているのかを評価する。
『考える力』は今まさに求められる力である。
【解答例（Sample Answer）】

1. Research Objective

This study aims to elucidate the genetic regulatory mechanisms involved in the biosynthesis of nicotine and other alkaloids in tobacco plants. Secondary metabolites produced by plants have long played a crucial role in human society, serving as medicines, stimulants, dyes, and more. Among these, nicotine in tobacco exhibits a strong insect-repellent effect and is regulated through a jasmonic acid-mediated signaling pathway within the plant. However, the detailed mechanisms of this complex regulation remain poorly understood. This research focuses on the role of the transcription factor NtMYC and the NIC genes, employing molecular genetics techniques to uncover their functions.

2. Research Background

While the biosynthesis and regulatory pathways of flavonoids, such as anthocyanins, have been extensively studied and largely clarified at the molecular level, much remains unknown about the regulation of other secondary metabolites like alkaloids. Alkaloids, which evolved during the later stages of plant speciation, are believed to have unique regulatory mechanisms distinct from those of flavonoids. Nicotine, a key alkaloid found in Solanaceae plants, serves as a prominent example. Tobacco, which has been cultivated and genetically manipulated for commercial purposes over many years, is particularly well-suited for genetic and genomic research due to its ease of genetic transformation and the availability of comprehensive genome data.

3. Research Goals

The first objective of this study is to clarify the role of the transcription factor NtMYC, which binds to the E-box sequence in the promoter region of nicotine biosynthetic genes. By using RNA interference (RNAi) and CRES-T techniques, we will generate transformed tobacco plants with suppressed NtMYC function and assess the impact on gene expression and alkaloid accumulation. Since multiple NtMYC genes have been identified, it is necessary to determine which members are involved in the regulation of the biosynthetic pathway. Additionally, we will investigate the relationship between NtMYC and the NIC regulatory genes to facilitate the molecular cloning of the NIC genes.

4. Research Methods

To pinpoint the location of the NIC genes, we will perform genetic mapping. Using an F2 segregating population obtained through hybridization, we will analyze the linkage between known SSR markers and the low-nicotine phenotype to estimate the chromosomal position of the NIC1 gene. Subsequently, we will develop high-density molecular markers based on genomic information to narrow down the NIC1 gene locus to within 100 kilobases. Once candidate genes are identified, we will sequence them in mutant strains and conduct RNAi-based expression suppression experiments to assess their impact on nicotine accumulation.

5. Significance of the Research

This study leverages molecular genetic approaches to elucidate the regulatory factors that control the accumulation of secondary metabolites in plants, providing a valuable complement to traditional biochemical research. The findings are expected to offer insights applicable not only to tobacco but also to other plant species that produce alkaloids. Furthermore, this research may contribute to the development of improved methods for the efficient and safe production of valuable natural products, benefiting both academic and industrial fields.

(Figures omitted)