


## 【Grant-in-Aid for Transformative Research Areas (A)】

### Biodiversity driven by mobile DNA elements and hosts : host response and trans-generation

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	Project Information	Project Number : 25A301 Keywords : Transposon, Germ cells, Evolution, Genome, Biodiversity	Project Period (FY) : 2025-2029

### Purpose and Background of the Research

#### Outline of the Research

##### ● What are Mobile DNA Elements?

Only about 2% of the human genome consists of protein-coding genes, while the remaining 98% is largely occupied by DNA sequences called transposons, collectively referred to as mobile DNA elements. Although the proportion of these elements varies among species, most organisms' genomes contain a significant amount of mobile DNA elements. These elements have the ability to move within the host genome, inserting themselves into different locations, which can introduce mutations in the genomic sequence. As a result, they are considered a potential threat, as they can cause genome instability and chromosomal distribution abnormalities, potentially leading to diseases such as cancer and even species extinction. To counteract these threats, host organisms have developed mechanisms over evolutionary time to suppress mobile DNA elements, thereby safeguarding their own genomic integrity and ensuring generational continuity.

##### ● The “Positive Aspects” of Mobile DNA Elements

On the other hand, changes in genome structure brought about by mobile DNA elements are now recognized as contributing to the acquisition of new gene functions and the diversification of phenotypes in host organisms. This suggests that mobile DNA elements are not merely “harmful” to their hosts but also possess the potential to exert beneficial effects. This is consistent with the fact that a wide range of organisms, from *Escherichia coli* to humans, have retained these elements in their genomes rather than eliminating them through evolutionary processes.

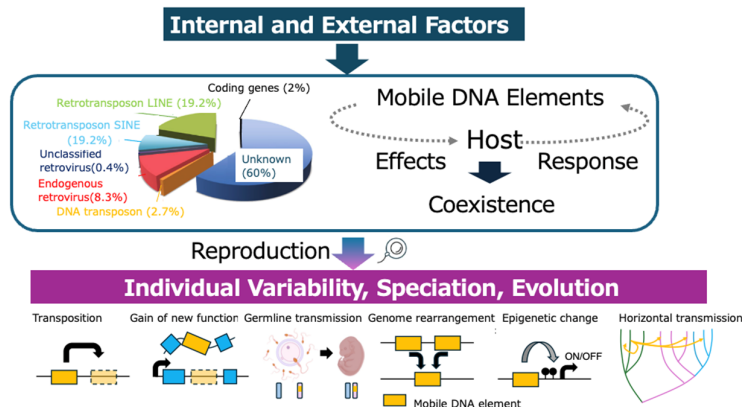


Figure 1. Effects and Impact of Mobile DNA Elements on Organisms

Over millions of years, mobile DNA elements and their host genomes have engaged in an ongoing evolutionary “arms race,” leading to a present-day coexistence. However, the details of this evolutionary relationship remain speculative (Figure 1).

- The Role of Mobile DNA Elements in Individual Variability, Speciation, and Evolution  
A deeper understanding of the “positive aspects” of mobile DNA elements is crucial for elucidating individual genetic variation, speciation, and the evolution of diverse organisms (Figure 1). This research aims to uncover how these elements contribute to the acquisition of novel traits and the process of speciation.

### Expected Research Achievements

#### ● Interdisciplinary Research for Understanding Mobile DNA Elements

This research integrates expertise from various disciplines, fostering interdisciplinary collaboration through the following approaches: 1. Combining experimental science with genomic informatics to artificially shorten natural timescales, enabling the investigation of evolutionary questions. 2. Establishing collaborative research networks that incorporate cutting-edge technologies to study a wide range of species. The collaborative framework integrates two major research projects—A01: Host Response and A02: Transgenerational Transmission (Figure 2).

#### ● A01: Host Response

This research focuses on elucidating the mechanisms by which various internal and external factors—such as temperature fluctuations and viral infections—activate mobile DNA elements. It also aims to clarify how interactions between mobile DNA elements and endogenous regulatory systems influence host chromatin structure, gene expression, and ultimately, organismal traits.

#### ● A02: Transgenerational Transmission

The A02 project investigates how host responses to mobile DNA elements contribute to species survival and diversification, particularly within the context of reproductive cycles and transgenerational inheritance. This research will seek to determine how they influence individual variation, diversification, speciation, and ultimately, evolutionary processes.

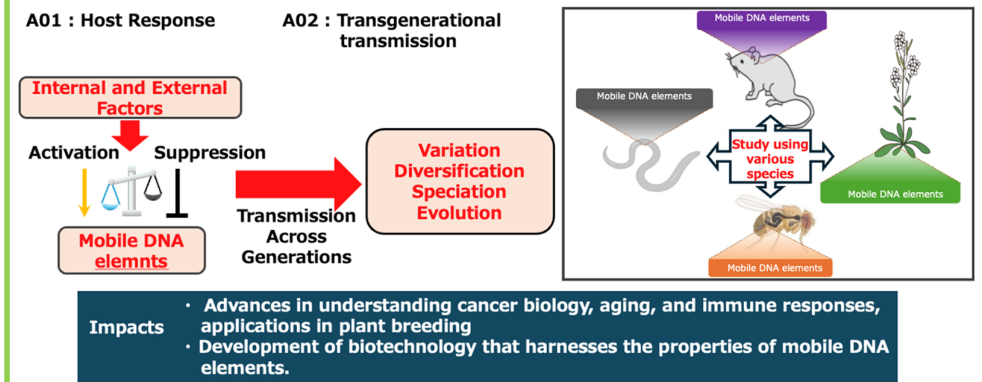


Figure 2. Our two major research projects

Homepage Address, etc. <https://mobilegenome.k.u-tokyo.ac.jp/>