

MOLECULAR  
BIOLOGY  
INTELLIGENCE  
UNIT

THE IMPACT OF SHORT  
INTERSPERSED ELEMENTS  
(SINES) ON THE HOST  
GENOME

Richard J. Maraia

National Institute of Child Health and Human Development  
National Institutes of Health  
Bethesda, Maryland, USA



**Springer**

New York Berlin Heidelberg London Paris  
Tokyo Hong Kong Barcelona Budapest

R.G. LANDES COMPANY  
AUSTIN

# CONTENTS

Preface .....	xiii
<b>1. Alu Elements as a Source of Genomic Variation:</b>	
<b>Deleterious Effects and Evolutionary Novelties .....</b>	<b>1</b>
<i>Damian Labuda, Ewa Ziętkiewicz and Grant A. Mitchell</i>	
1. Introduction .....	1
2. Alu Elements and Human Diseases .....	3
3. Evolutionary Novelties .....	12
4. Conclusion .....	18
<b>2. Origin and Evolution of Alu Repetitive Elements .....</b>	<b>25</b>
<i>Jerzy Jurka</i>	
1. Introduction .....	25
2. Origin and Early Evolution of Alu Predecessors and Related Genes .....	26
3. The Origin of Dimeric Alu Gene(s) .....	29
4. Subfamily Structure of Alu Repeats .....	30
5. Discussion .....	37
<b>3. SINE Master Genes and Population Biology .....</b>	<b>43</b>
<i>Prescott L. Deininger and Mark A. Batzer</i>	
1. Concerted Evolution of SINES .....	43
2. Master Genes .....	44
3. Subfamily Formation .....	44
4. The Nature of Master Genes .....	45
5. The BC1 RNA Gene as an ID Master Element .....	46
6. The Frequency of Master Genes .....	48
7. Master Genes vs. Master Subfamilies .....	48
8. Recent Alu Insertions .....	48
9. SINES as Molecular Fossils .....	53
10. Population Fixation and Concerted Evolution of SINES .....	54
11. SINES as Markers of Populations .....	55
12. SINES as Markers for Forensic Identity Testing .....	56
<b>4. Evolution of tRNA-Derived SINES .....</b>	<b>61</b>
<i>Norihiro Okada and Kazuhiko Ohshima</i>	
1. Introduction .....	61
2. Most SINES Are Derived From tRNA .....	61
3. A General Strategy for Construction of a tRNA-Like Secondary Structure for SINES, with a Specific Example .....	62
4. Several Distantly Related SINES Exhibit Similarities .....	68
5. A Possible Model for the Initial Generation of tRNA-Derived SINES .....	69
6. The Possibility of Horizontal Transmission .....	75

<b>5. SINEs as a Genomic Scrap Yard: An Essay on Genomic Evolution</b>	<b>81</b>
<i>Wojciech Makalowski</i>	
1. Introduction .....	81
2. SINEs and Recombination Events .....	85
3. SINEs as Translated Parts of Host Genes .....	85
4. SINEs as Transcription Promoters .....	92
5. SINEs as a Source of Polyadenylation Signals .....	92
6. SINEs as a Source of Regulatory Elements .....	95
7. SINEs and Chromatin Structure .....	97
8. SINEs and New Gene Functions .....	98
9. Conclusion .....	98
<b>6. Alu: What's the Use?</b> .....	<b>105</b>
<i>Carl W. Schmid and Carol M. Rubin</i>	
1. Abstract .....	105
2. Background .....	106
3. Mobility of Alu Repeats: Isolating a Source Gene .....	108
4. Alu Methylation Requires a Functional Explanation .....	110
5. Transcriptional Expression of Alus .....	113
6. Conclusion .....	117
<b>7. SINE-Derived Motifs and the Regulation of RNA</b>	
<b>Polymerase II Transcripts</b> .....	<b>125</b>
<i>Frédérique Vidal and François Cuzin</i>	
1. Introduction .....	125
2. Modulation of Expression of Structural Genes by SINEs .....	126
3. Conclusion .....	128
<b>8. Alu Silencing Mechanisms: Implications for the Modulation of Local Chromatin Structure</b> .....	<b>133</b>
<i>Bruce H. Howard, Valya R. Russanova and Ella W. Englander</i>	
1. Transcriptional Silencing of Alu Elements In Vivo .....	133
2. Mechanisms of Repression .....	134
3. Consequences of Transcriptional Competence .....	136
4. Alu Elements as Cis-Acting Chromatin Elements .....	136
5. Conclusions .....	138

<b>9. Activation of RNA Polymerase III Transcription of Human Alu Elements by Adenovirus Type 5 and Herpes Simplex Virus Type 1 .....</b>	<b>143</b>
<i>Barbara Panning and James R. Smiley</i>	
1. Introduction .....	143
2. Results .....	144
3. Discussion: Possible Mechanisms and Implications.....	155
<b>10. Alu-Family SINE RNA: Interacting Proteins and Pathways of Expression .....</b>	<b>163</b>
<i>Richard J. Maraia and Jasmit Sarrova</i>	
1. Abstract .....	163
2. Introduction .....	164
3. Recent Progress.....	174
4. Future Directions .....	184
5. Conclusions .....	188
<b>11. SINEs and Trans-Acting Factors .....</b>	<b>197</b>
<i>Glen W. Humphrey</i>	
1. Introduction .....	197
2. SINEs as Binding Sites for Pol III Transcription Factors .....	198
3. SINEs as Binding Sites for Pol II Transcription Factors .....	207
4. SINEs as Origins of Replication.....	214
<b>12. Quantitative Study of Alu Repeated Sequences in Primate Genomes, Yielding Insight into Their Sources and Evolution .....</b>	<b>223</b>
<i>Roy J. Britten</i>	
1. Introduction .....	224
2. Lack of Alu Lineages .....	224
3. Relationship of Different Positions within a Site.....	228
4. Global Correlations in the Alu Sequence .....	228
5. Conclusion .....	229
<b>Index .....</b>	<b>233</b>