The genomics of small RNAs in insects

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Introduction

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Piwi-interacting RNAs (piRNAs)	2006	2006

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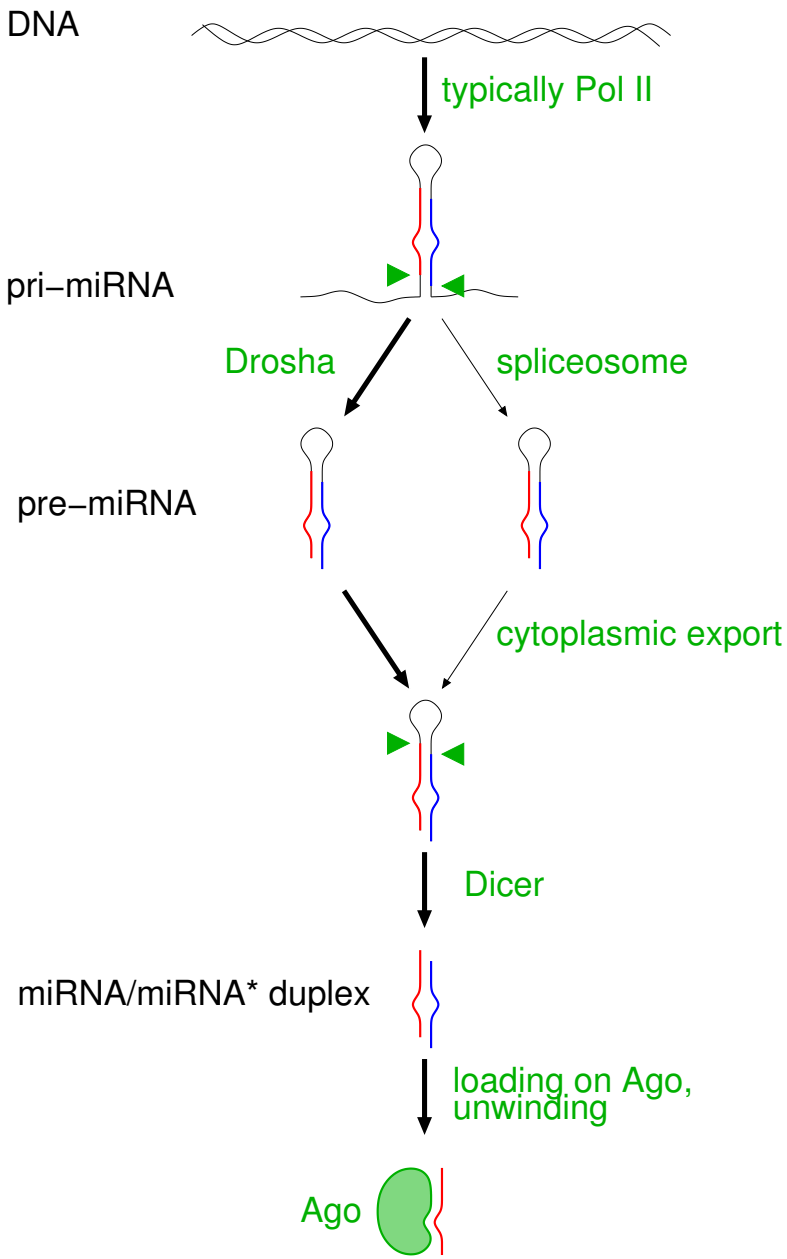
Interact with members of the Argonaute protein family.

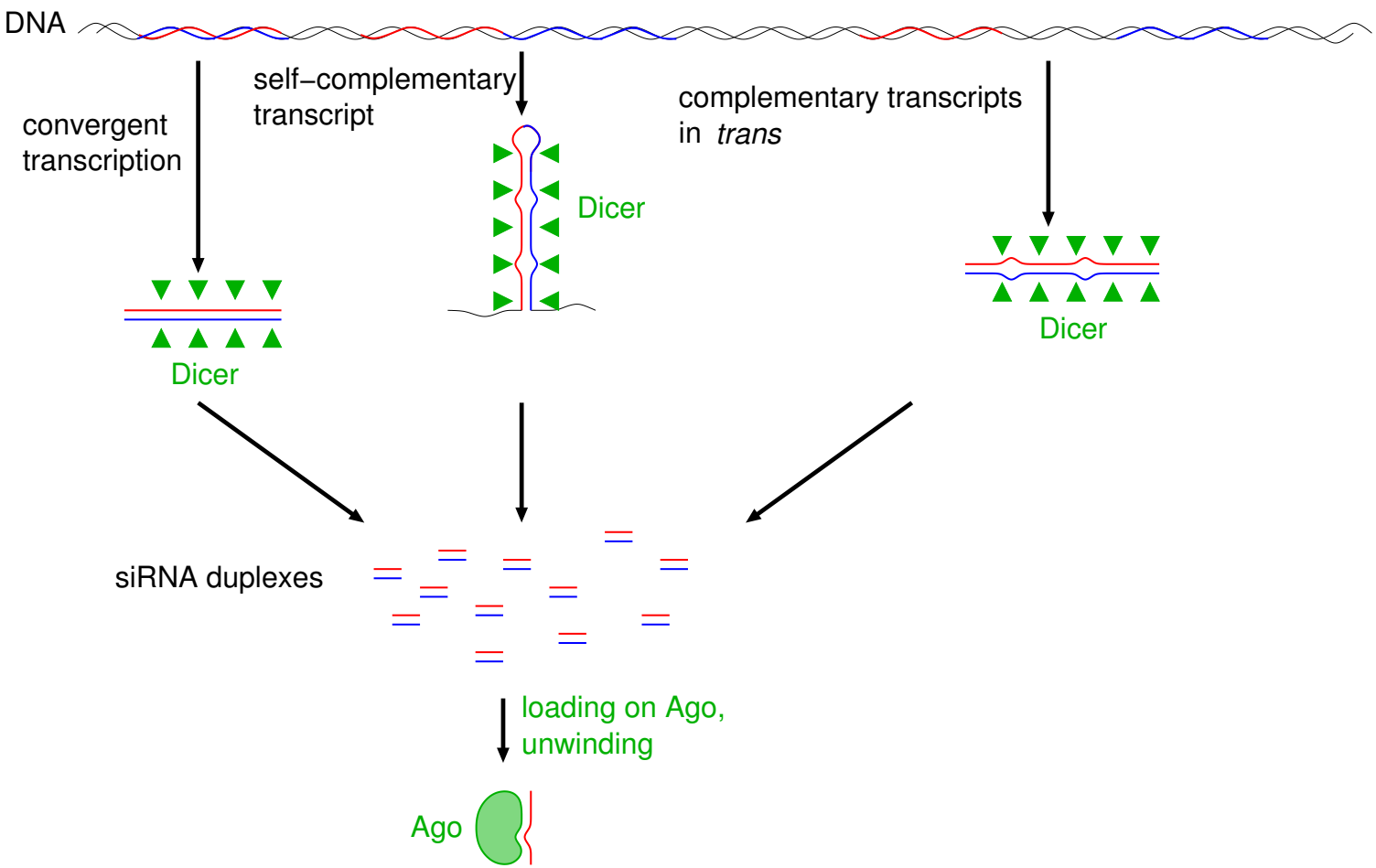
Three subfamilies:

- Ago (miRNAs and siRNAs);
- Piwi (piRNAs);
- Wago (some siRNAs in nematodes).

microRNA biogenesis



siRNA biogenesis



piRNA biogenesis

2006:
Does not involve Dicer.
Derive (apparently) from single-stranded precursors.

Expressed mostly in the germ line.

microRNA genes in insects

Low diversity: < 500 known miRNA genes per species.

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Low diversity: $<$ 500 known miRNA genes per species.

	Number of miRNA genes	Relative to coding genes		
		intergenic	sense	antisense
D. melanogaster	238	38%	53%	9%
D. pseudoobscura	208	100%	0%	0%
A. gambiae	67	100%	0%	0%
A. mellifera	174	100%	0%	0%
B. mori	483	100%	0%	0%

(data from miRBase, version 17: April 2011)

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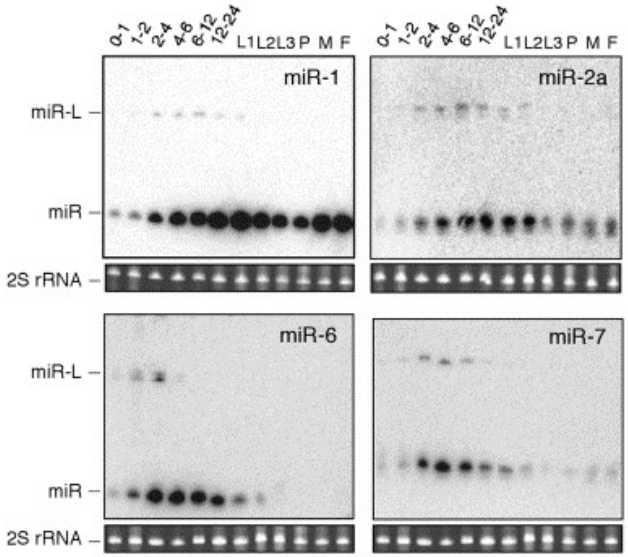
Very high abundance (for some miRNAs).



(from Aravin *et al.*, 2003)

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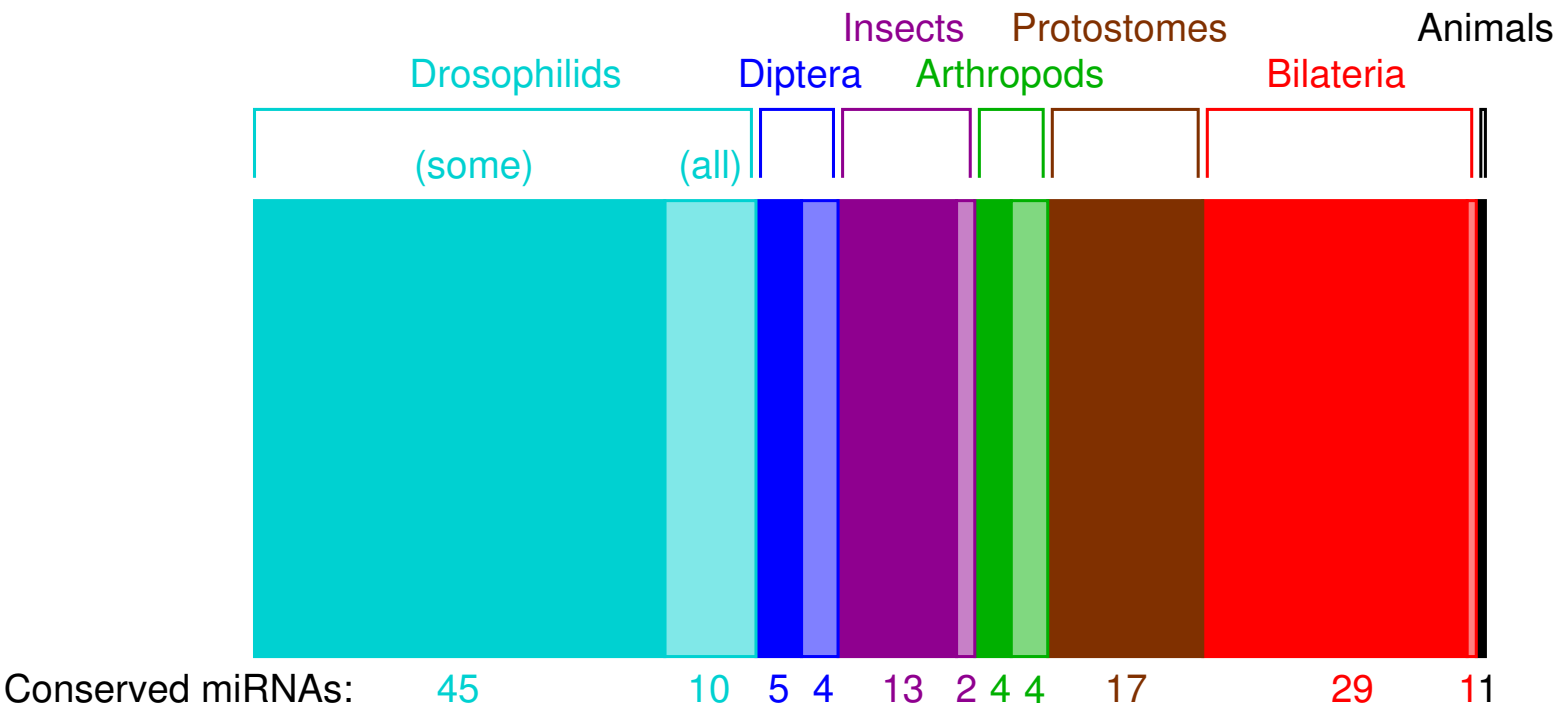
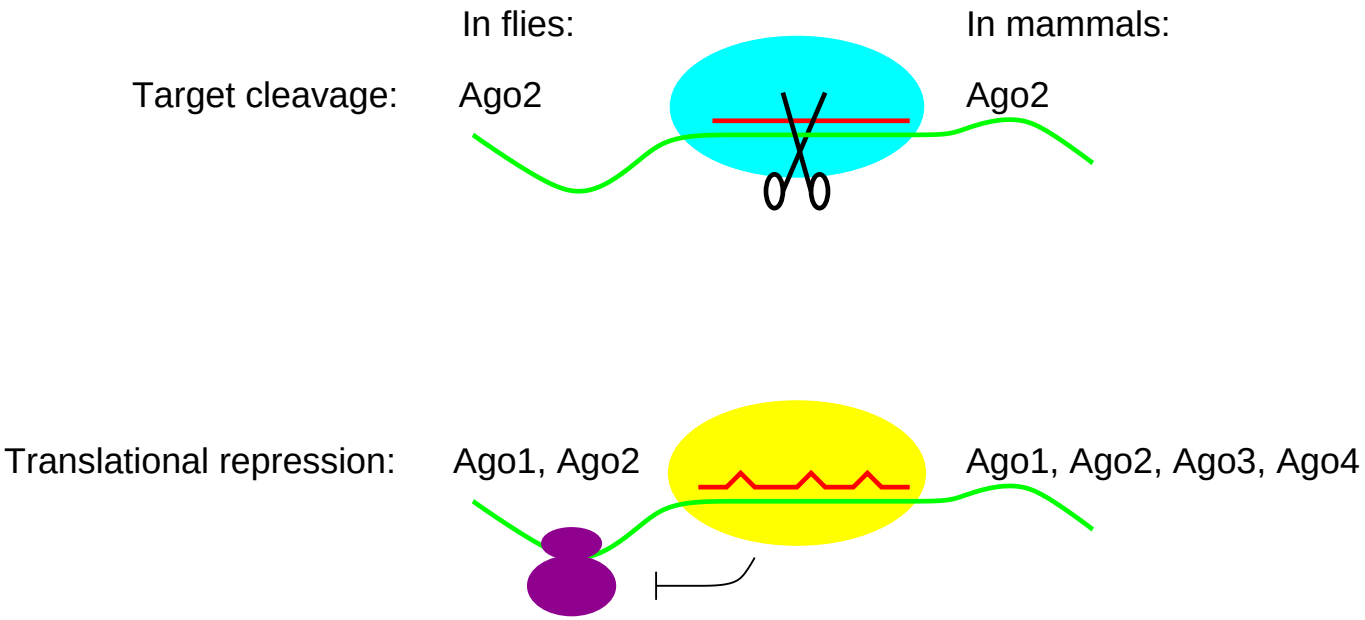
miRNAs can be very well conserved in animals.



miRNA mode of action



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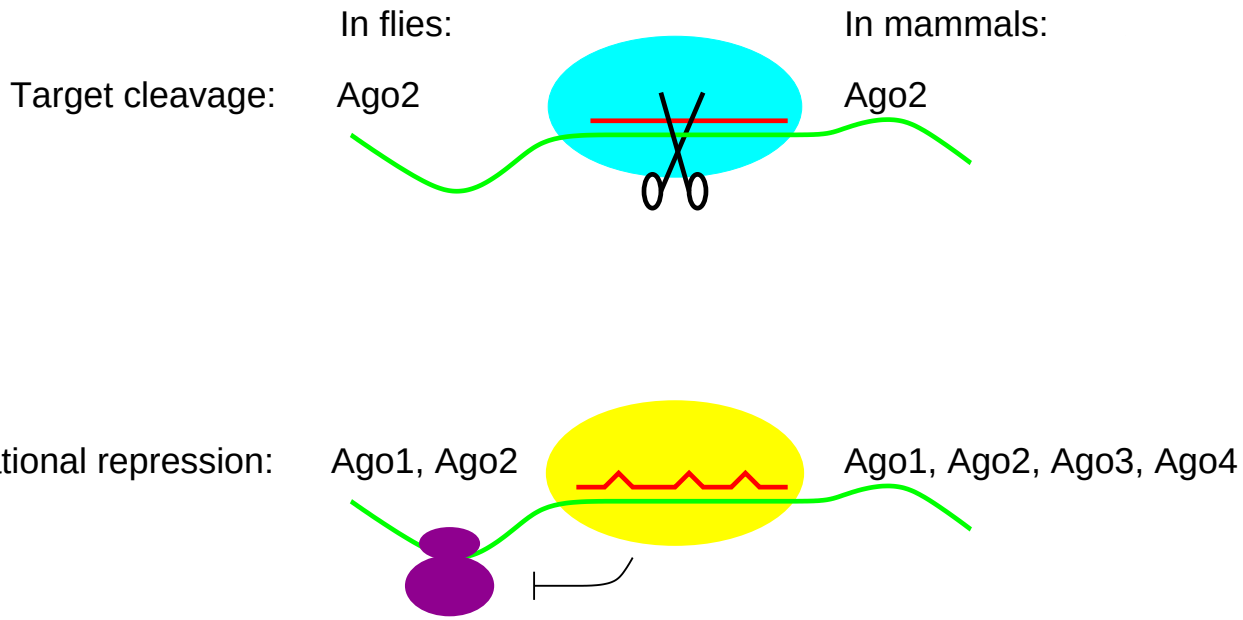
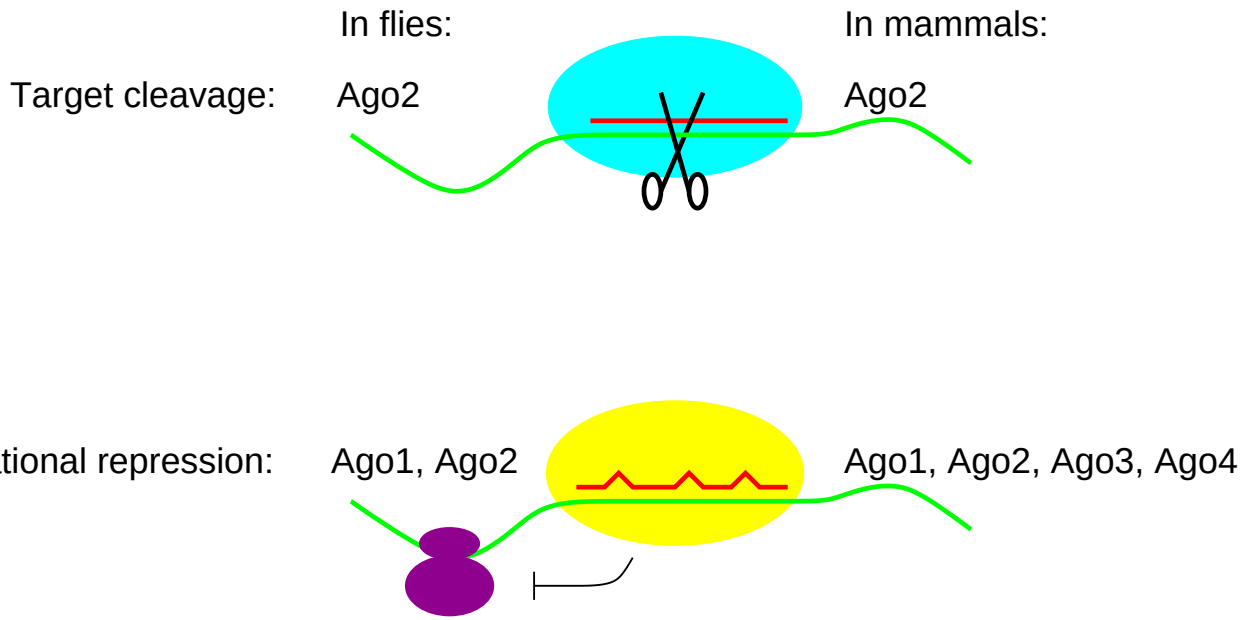


Definition of a functional imperfect complementarity?

miRNA mode of action



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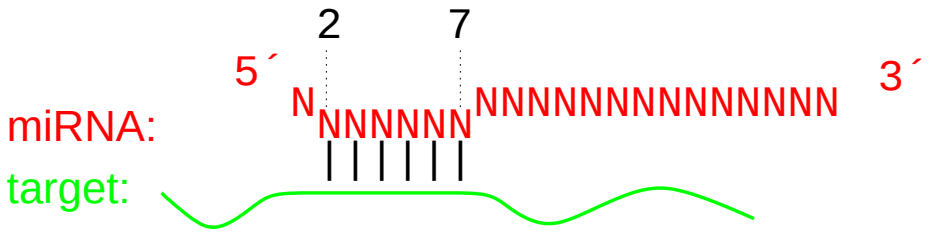

$\longrightarrow$ the "seed"

miRNA mode of action

Target prediction algorithms: find evolutionarily conserved seed matches in 3´ UTRs.

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$\Longrightarrow$ miRNAs are implicated in every biological process in animals.

Maybe just a small subset of predicted targets are really, functionnally targeted.

piRNAs are made from genomic clusters

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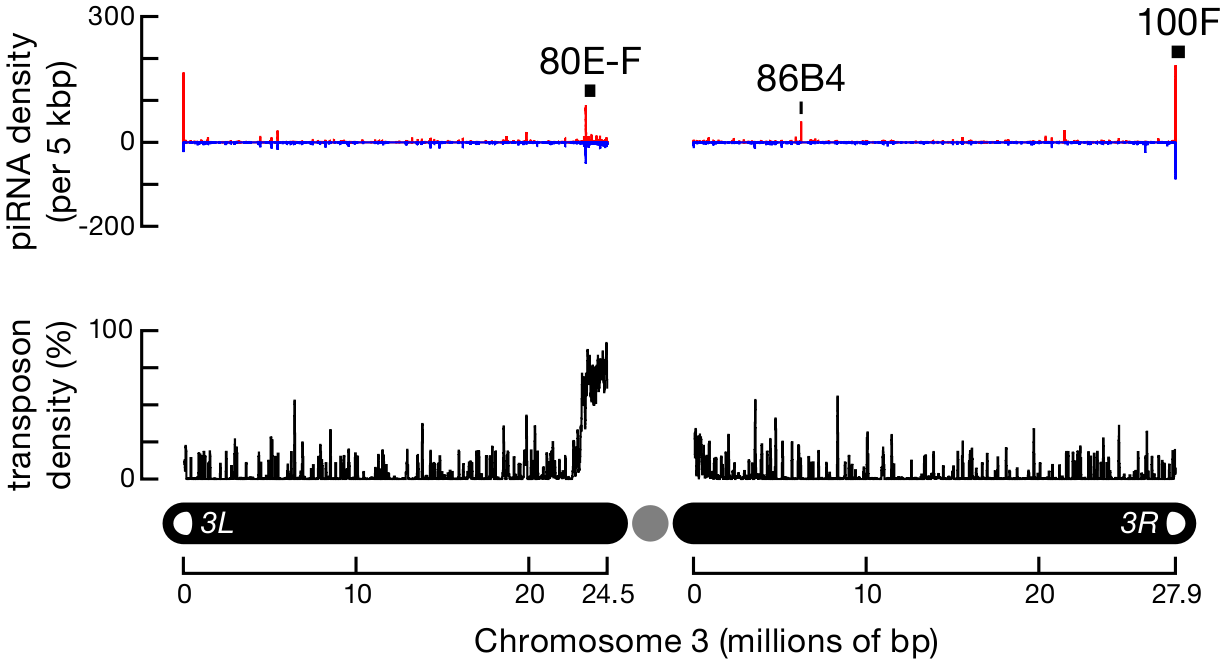

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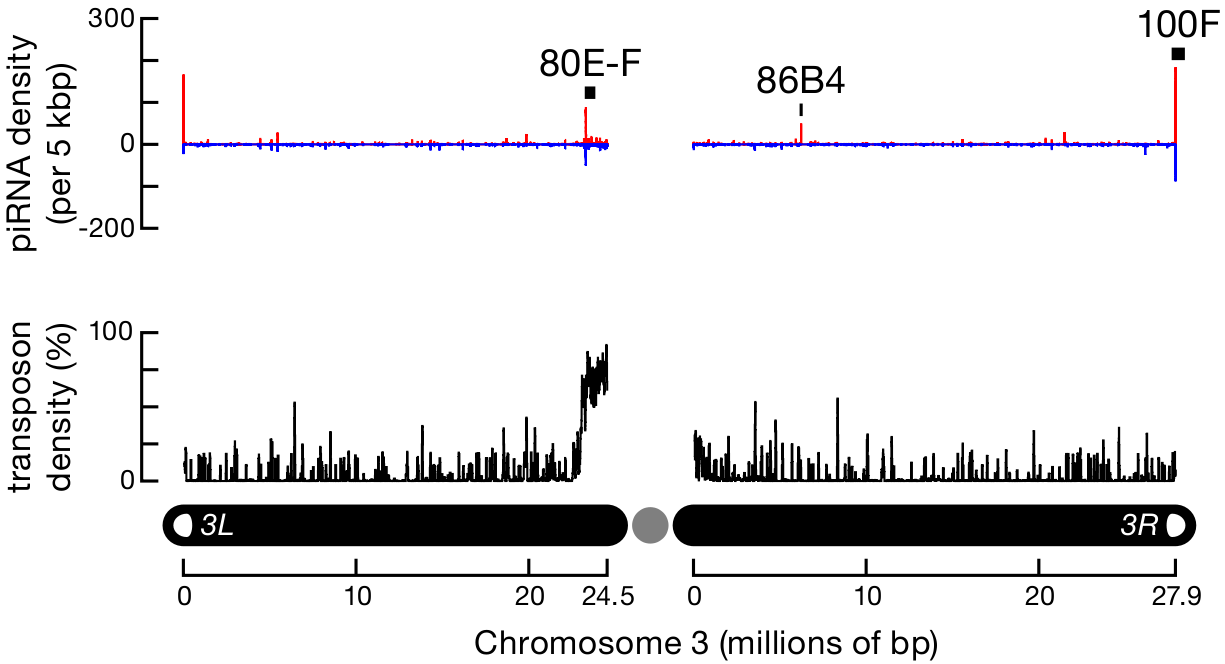

Large diversity in sequence (millions of different piRNAs), each of them being poorly abundant.

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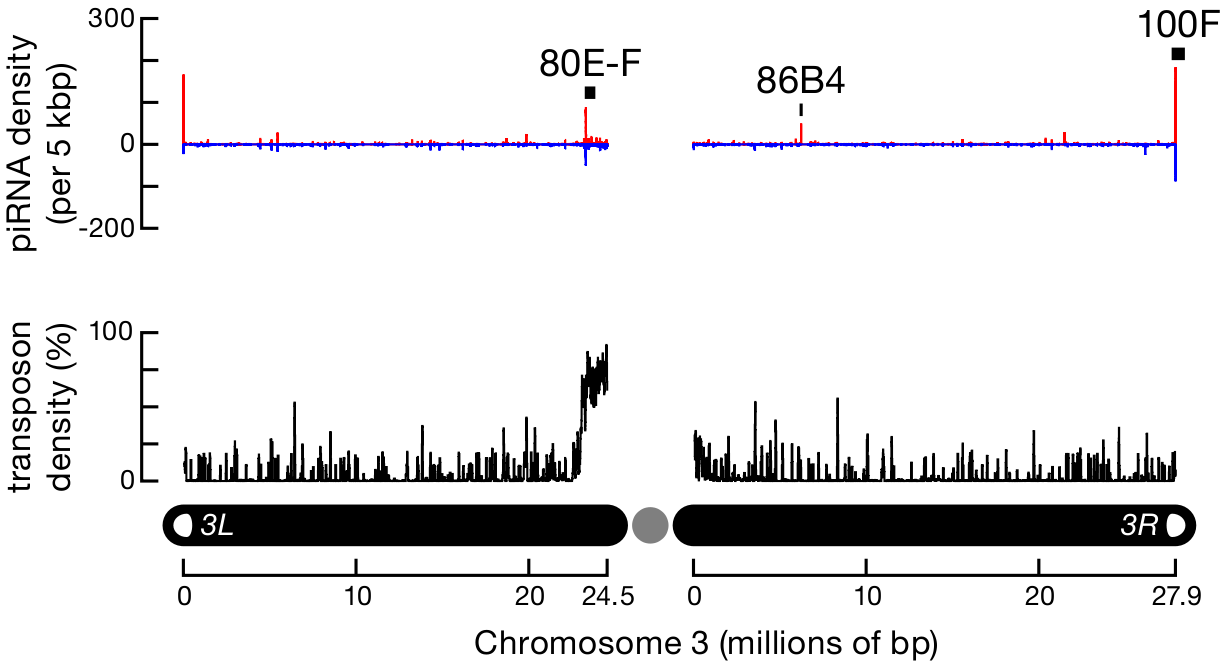

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Poorly conserved, but piRNA cluster locations are conserved.

piRNA biogenesis: a reactive “immune” system

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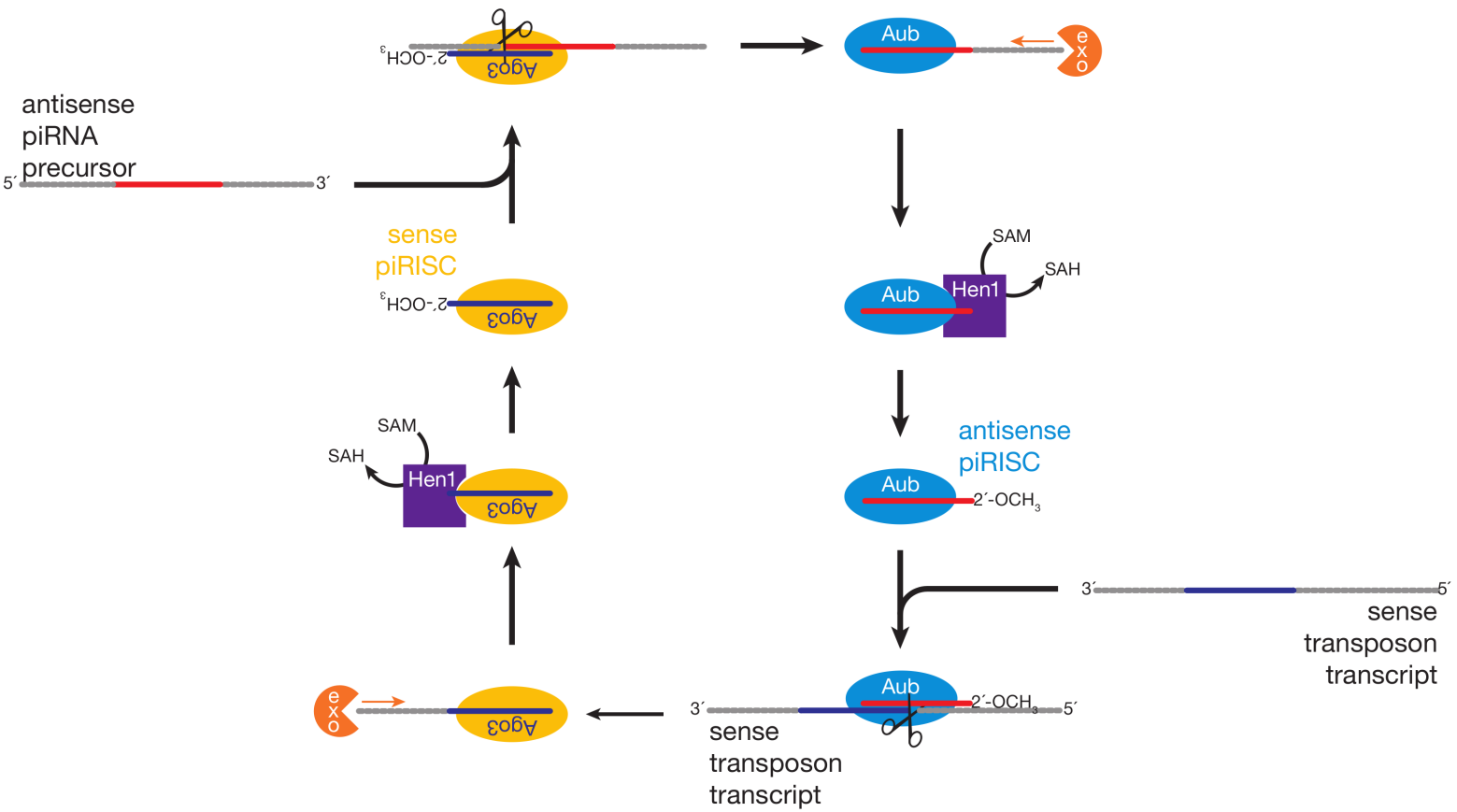

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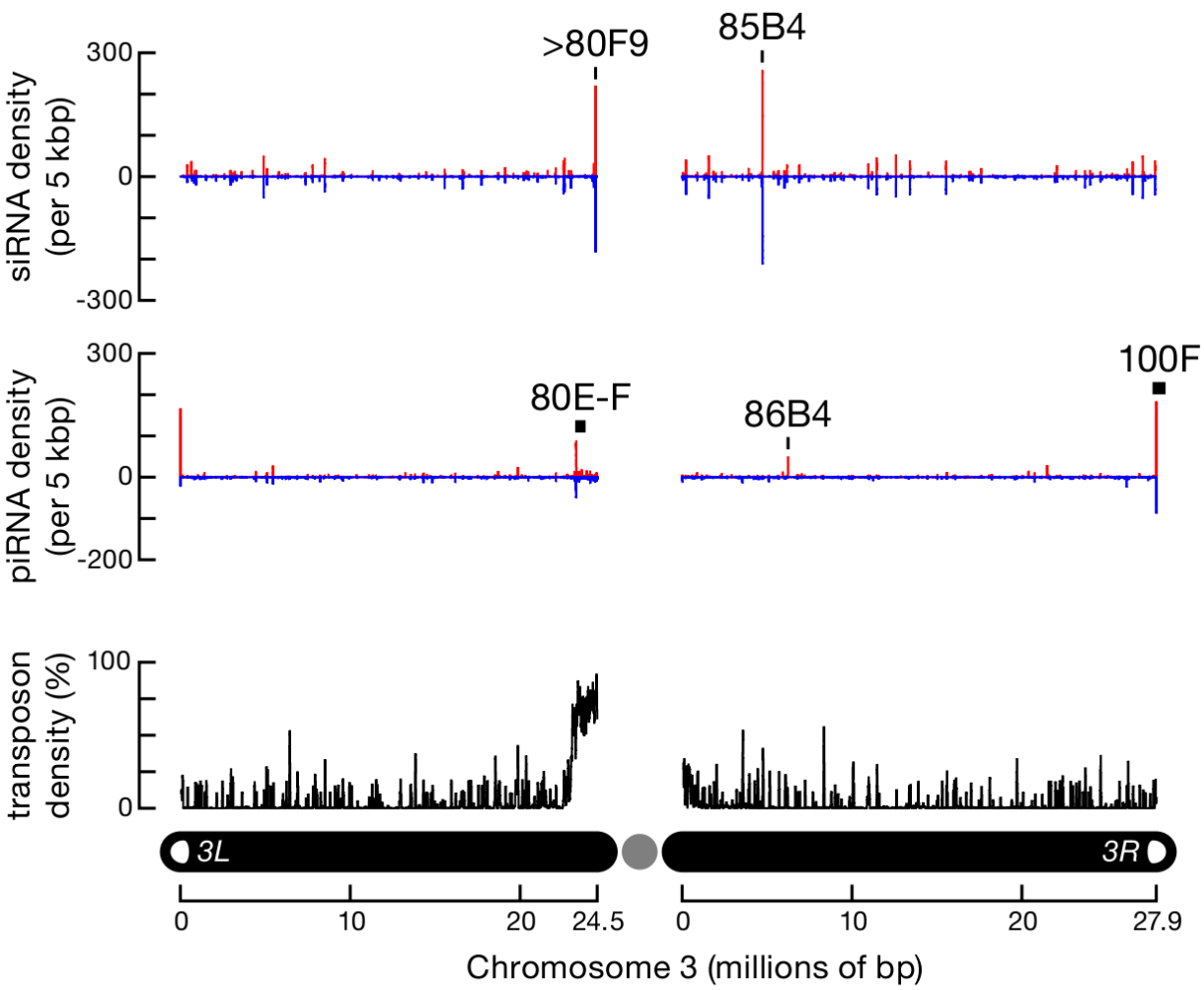
Detection of endogenous siRNAs in *Drosophila* by deep-sequencing.

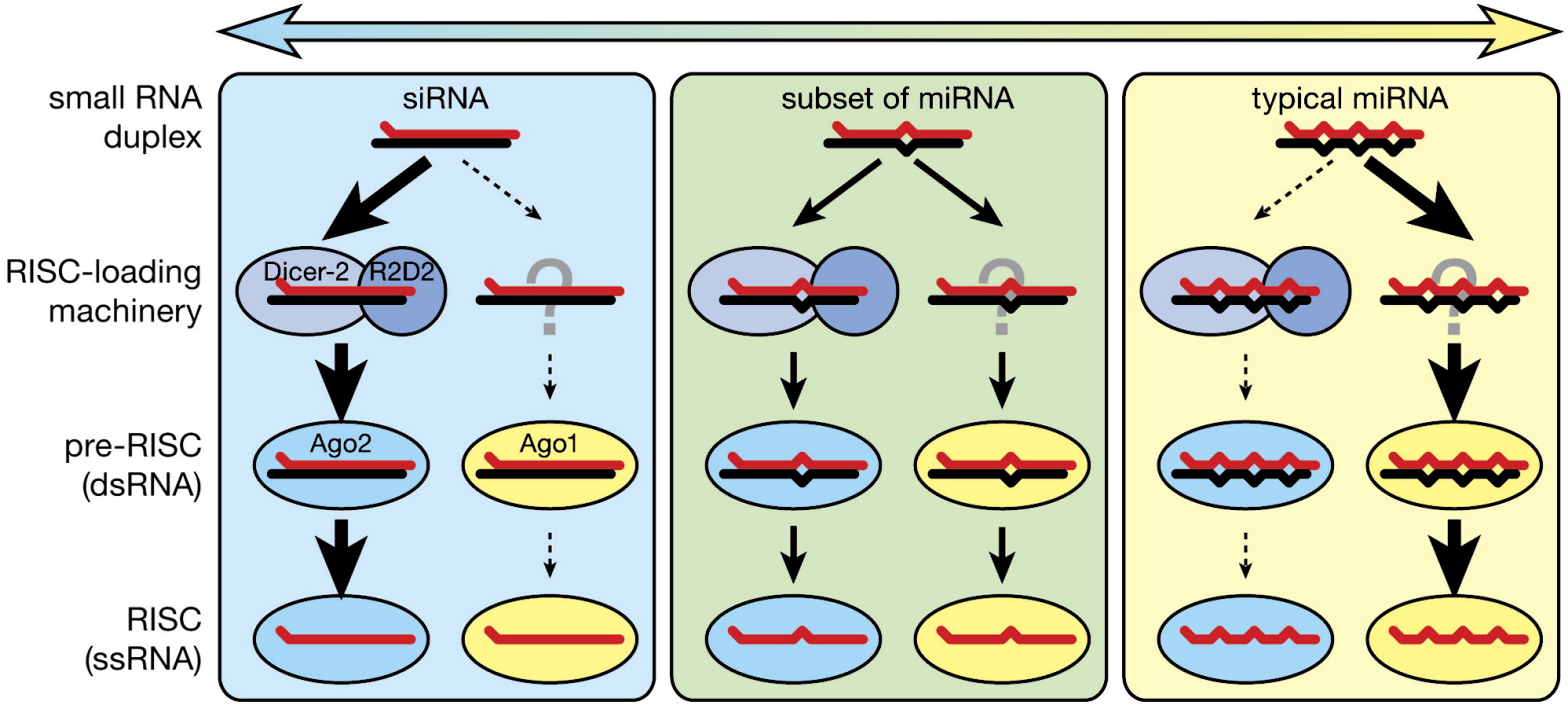
Endogenous siRNAs



Associated proteins: variations on common themes

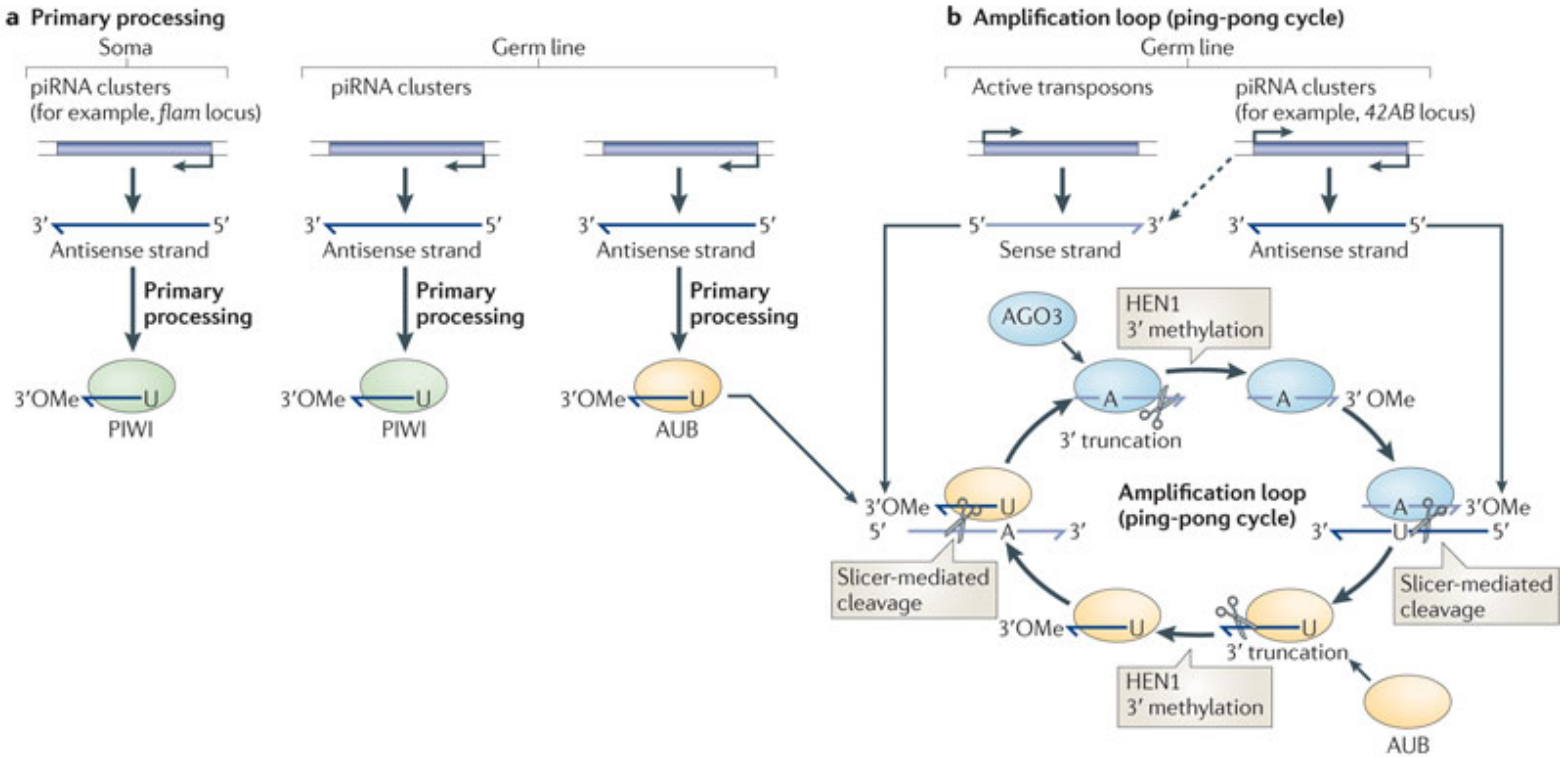
- Specialized effectors for siRNAs and miRNAs in insects.
- An alternative piRNA biogenesis pathway in flies.
- An RdRP in an arthropod.

miRNA sorting: an insect-specific feature



(from Tomari *et al.*, 2007)

Two biogenesis pathways for piRNAs



(adapted from Siomi *et al.*, 2011)

Conclusion

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- An ancient evolutionary origin.
- A peculiar genomic organization for piRNAs and siRNAs.
- Biological functions under investigation.
- Insect-specific features for miRNA and piRNA biogenesis: uncoupling biological functions.

Acknowledgements

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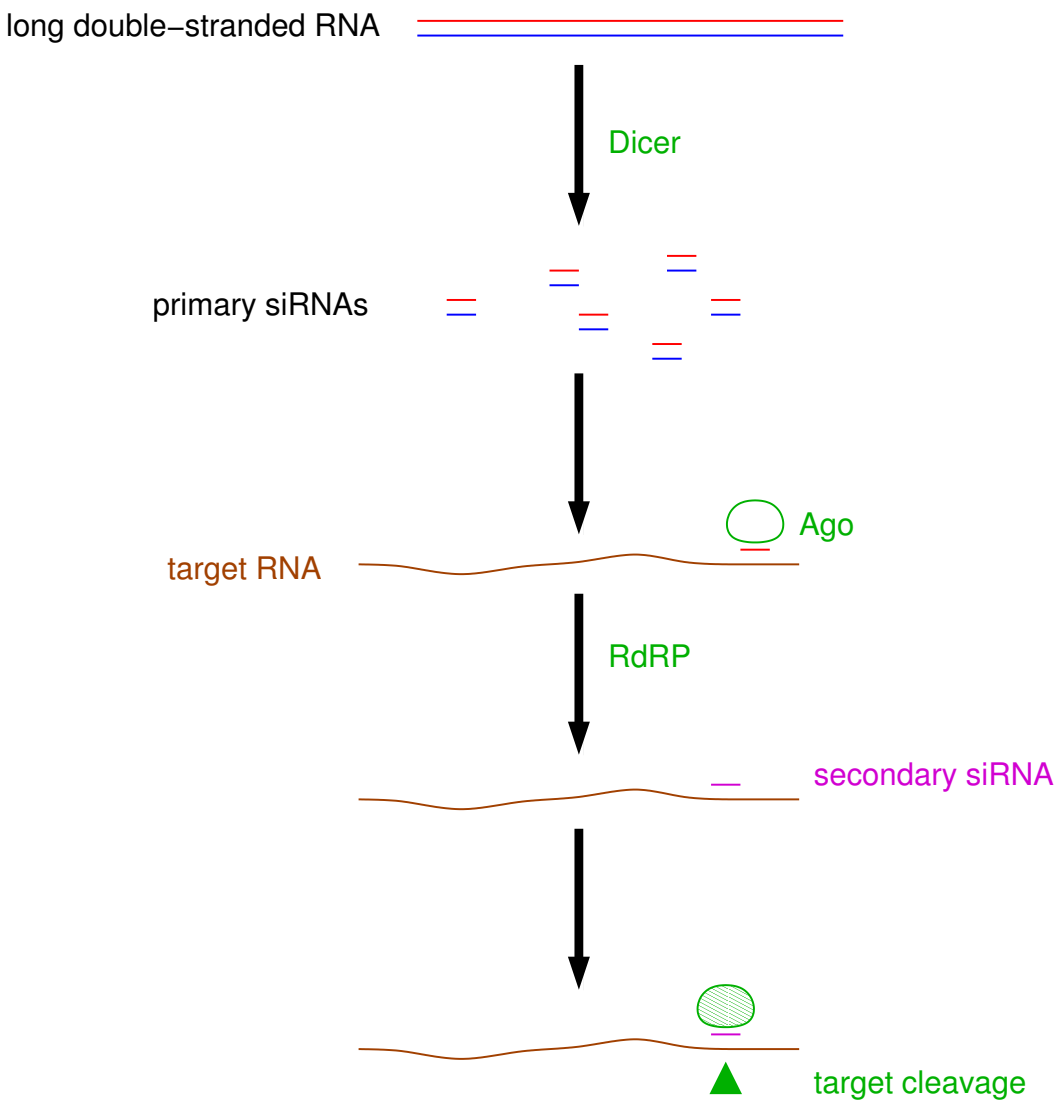
siRNA biogenesis: how widespread are RdRP's?



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Ixodes scapularis has four RdRP genes.