

# Plant Small RNAs: Biogenesis and Functions

**Plant Small RNAs Poster:** Biogenesis and functions of plant small RNAs. For further information, see [1-8] and refs therein. Send questions and comments to Blake Meyers (BMeyers@danforthcenter.org) and/or to Dmitry Shevela (info@scigrafik.se).

**Abbreviations:** AGO, Argonaute protein; CLSY1, chromatin remodeling factor Classy 1; DCL, Dicer-like proteins; DDL, forkhead-associated domain protein Dawdle; DMS3, hinge-domain protein defective in meristem silencing 3; DRD1, defective in RNA-directed DNA methylation 1; DRM2, domains rearranged methyltransferase 2; dsRNA, double-stranded RNA; easiRNAs, epigenetically activated siRNAs; ER, endoplasmic reticulum; hc-siRNAs, heterochromatic siRNAs; HSP90, heat-shock protein 90; HEN1, methyltransferase Hua Enhancer 1; HST, Hasty protein; HYL1, Hyponastic Leaves 1 protein; lncRNAs, long non-coding RNAs; miRNAs, messenger RNAs; miRNA, microRNA; nat-siRNAs, natural antisense transcript siRNAs; nt, nucleotide; phasiRNA, phased, secondary siRNA; Pol, RNA polymerase; RDM1, required for DNA methylation 1 RDR2, RNA-dependent RNA polymerase 2; rRNAs, ribosomal RNAs; SE, Serrate; SGS3, suppressor of gene silencing 3; SHH1, Sawadnee Homeodomain Homolog 1; siRNAs, small interfering RNAs; snRNAs, small nuclear RNAs; snoRNAs, small nucleolar RNAs; TGH, G-patch domain protein Tough; tRFs, tRNA-derived fragments; tRNAs, transfer RNAs; tasiRNAs, trans-acting siRNAs.

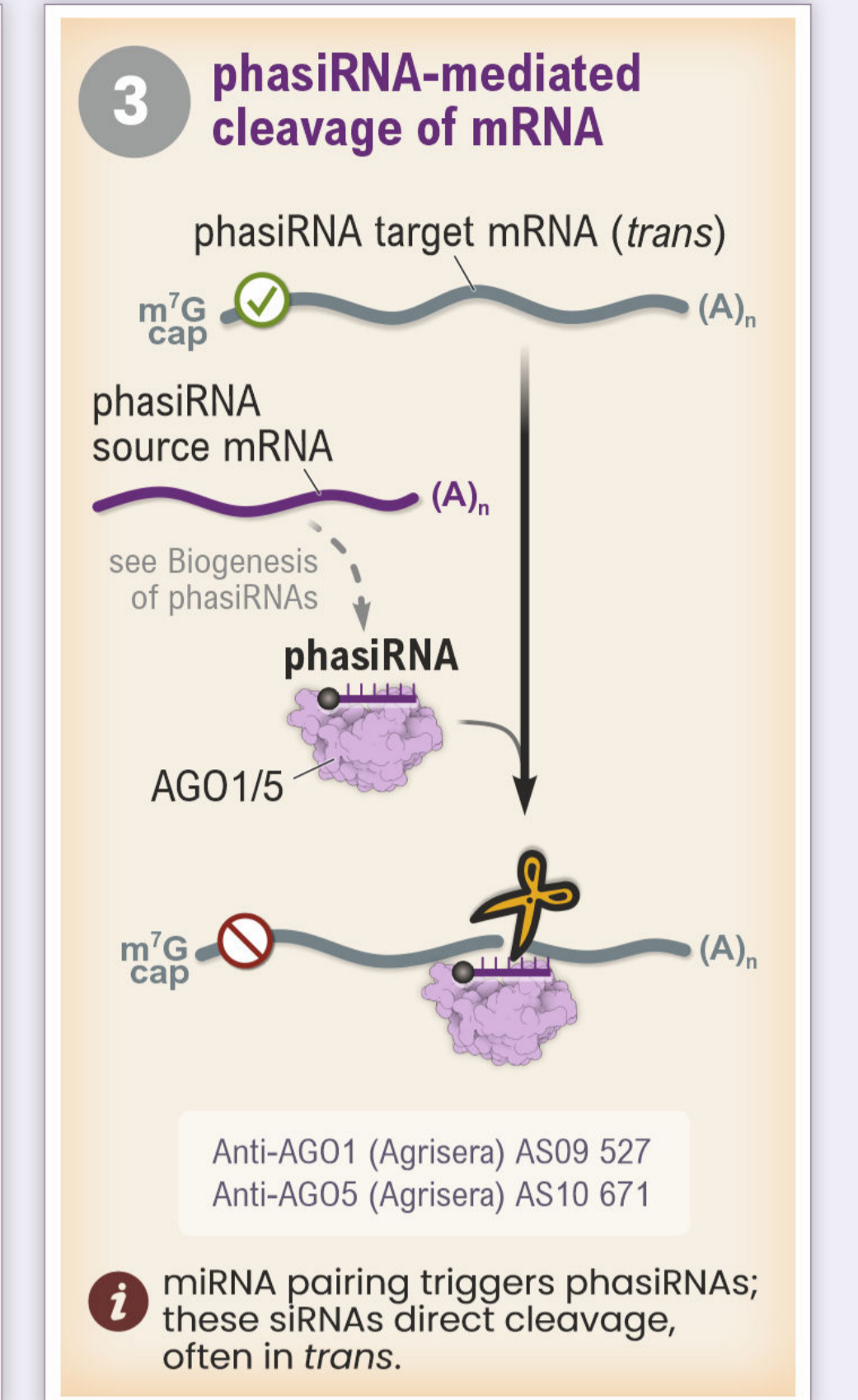
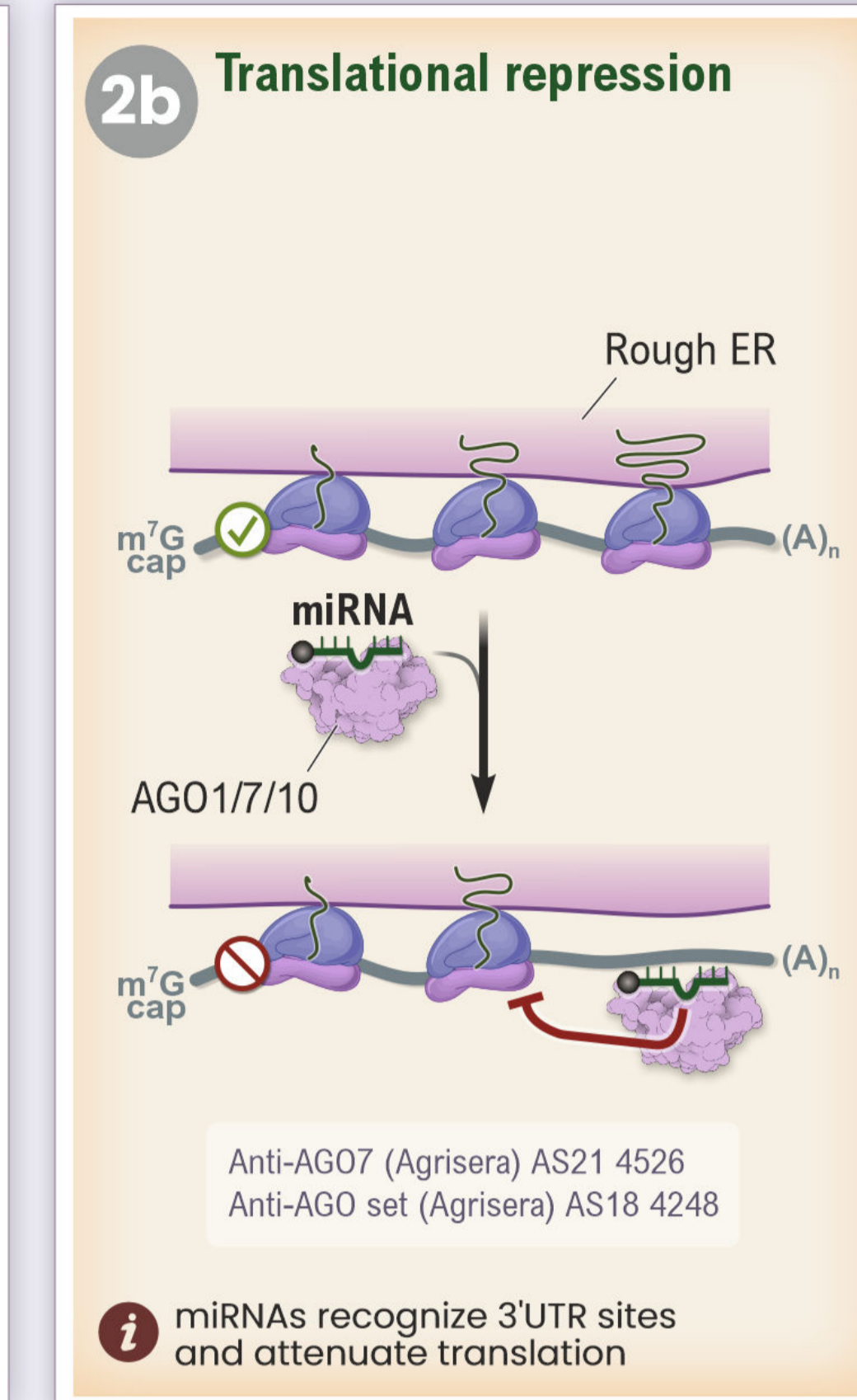
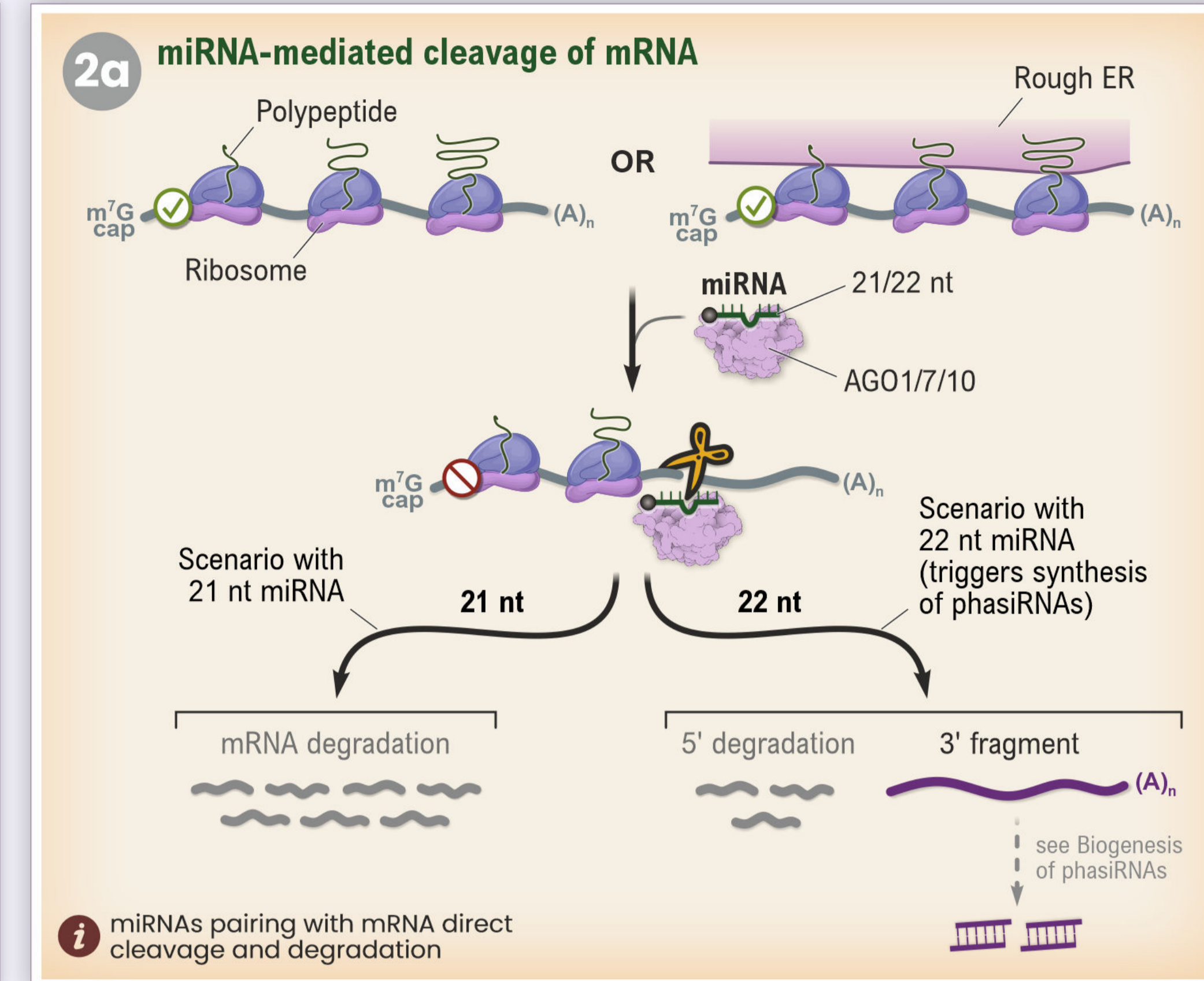
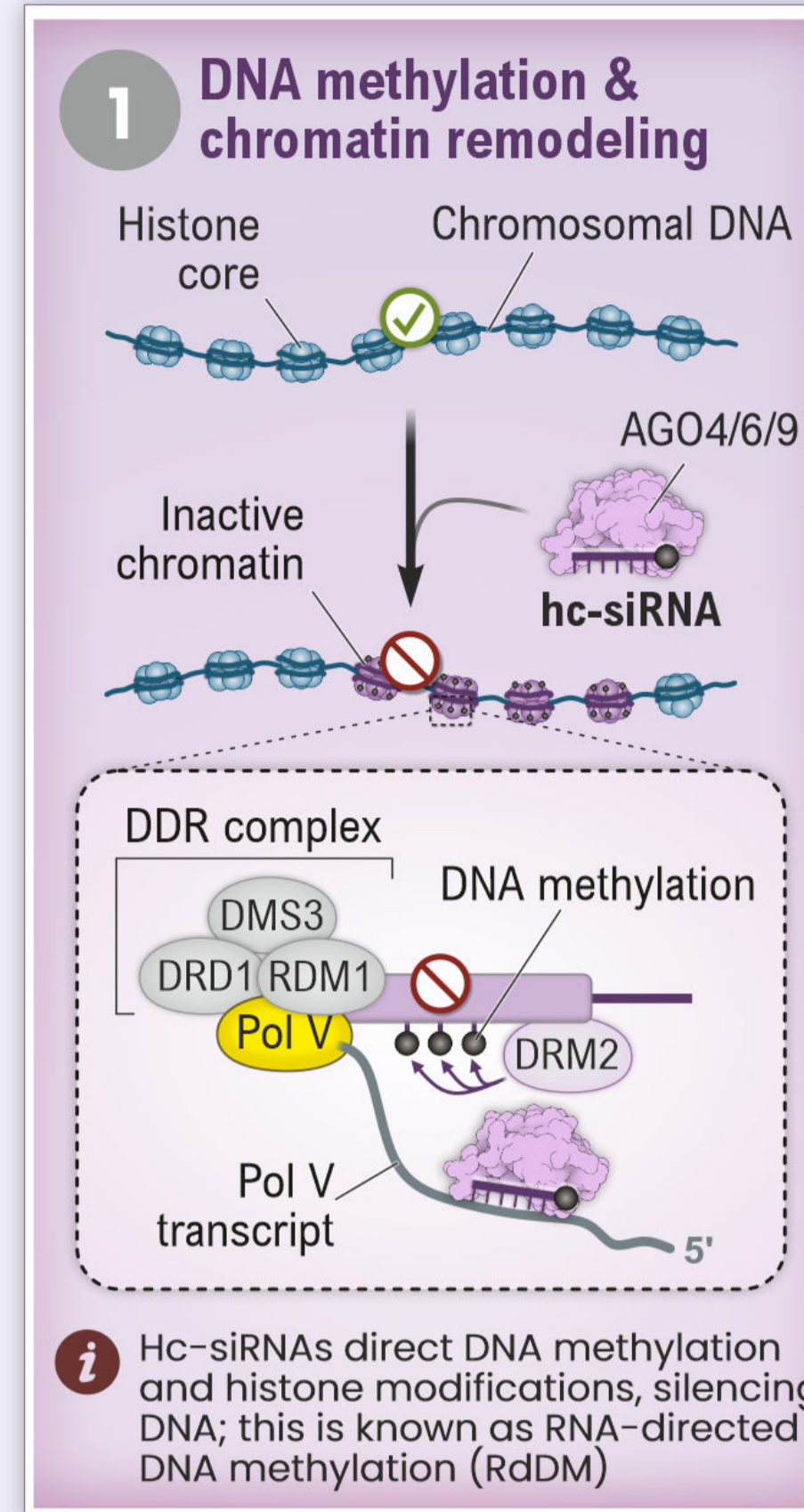
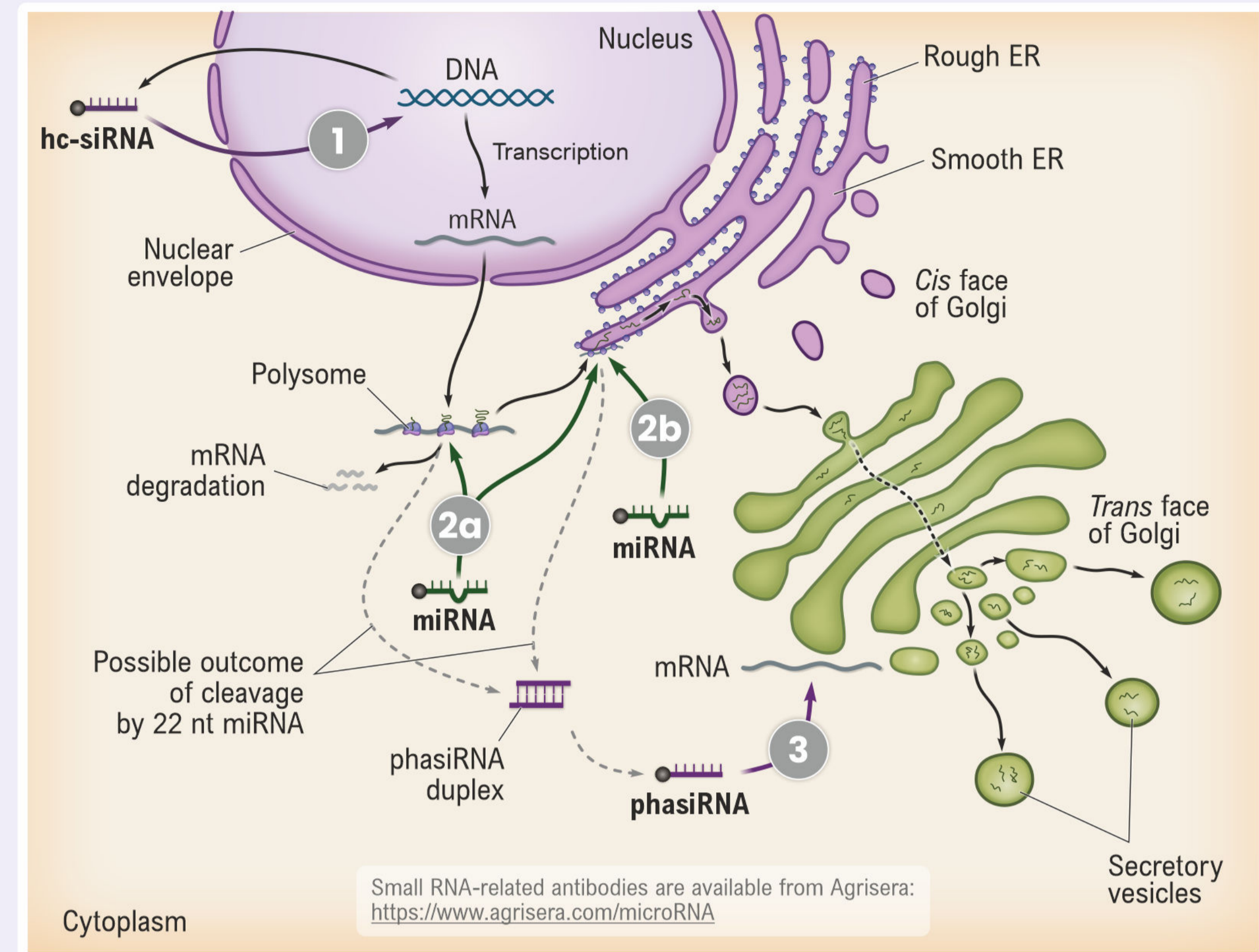
**Notes:** Complexes and cofactors were generated with Protein Imager software using coordinates of the following PDB codes: 2xcm, 3htx, 4g0y, 7eld, 7roz, and 7vg2.

**Acknowledgements:** We thank Joanna Porankiewicz-Asplund and Edith Kalén for their valuable comments and corrections. We are highly grateful to Agrisera for sponsoring the poster design, printing, and free distribution at conferences around the world.

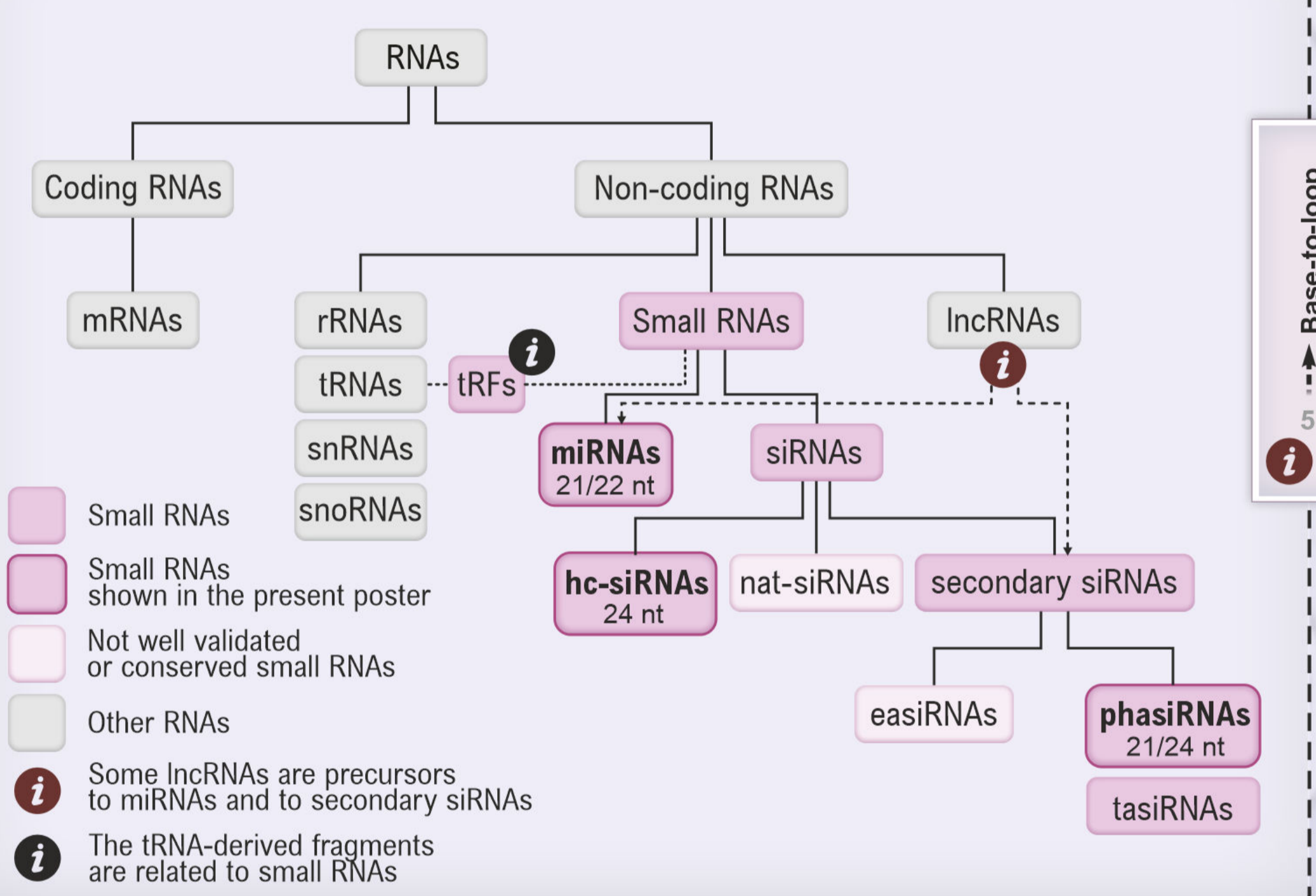
**Citation:** Meyers B, Zhan J, Shevela D, Slotkin K (2022) Plant Small RNAs: Biogenesis and Functions, *Agrisera Educational Poster 6*: doi:10.6084/m9.figshare.21186073.

**References:** [1] Axtell MJ (2013) Classification and comparison of small RNAs from plants. *Annu. Rev. Plant Biol.* 64: 137-159; [2] Liu Y, Teng C, Xia R, Meyers BC (2020) PhasiRNAs in plants: Their biogenesis, genetic sources, and roles in stress responses, development, and reproduction. *Plant Cell* 32: 3059-3080; [3] Yu Y, Jia T, Chen X (2017) The 'how' and 'where' of plant microRNAs. *New Phytol.* 216: 1002-1017; [4] Cuadrado-Gil D, Slotkin R (2016) Non-canonical RNA-directed DNA methylation. *Nat. Plants* 2: 16163; [5] Löffler A, Singh J, Fukudome A et al. (2022) A DCL3 dicing code within Pol IV-RDR2 transcripts diversifies the siRNA pool guiding RNA-directed DNA methylation. *eLife* 11: e73260; [6] Gonzalo L, Tossalini I, Gulanicz T et al. (2022) R-loops at microRNA encoding loci promote co-transcriptional processing of pri-miRNAs in plants. *Nat. Plants* 8: 402-418; [7] Borges F, Martienssen RA (2015) The expanding world of small RNAs in plants. *Nat. Rev. Mol. Cell Biol.* 16: 727-741; [8] McCue AD, Panda K, Nuthikattu S et al. (2015) ARGONAUTE 6 bridges transposable element mRNA-derived siRNA to the establishment of DNA methylation. *EMBO J.* 34: 20-35.

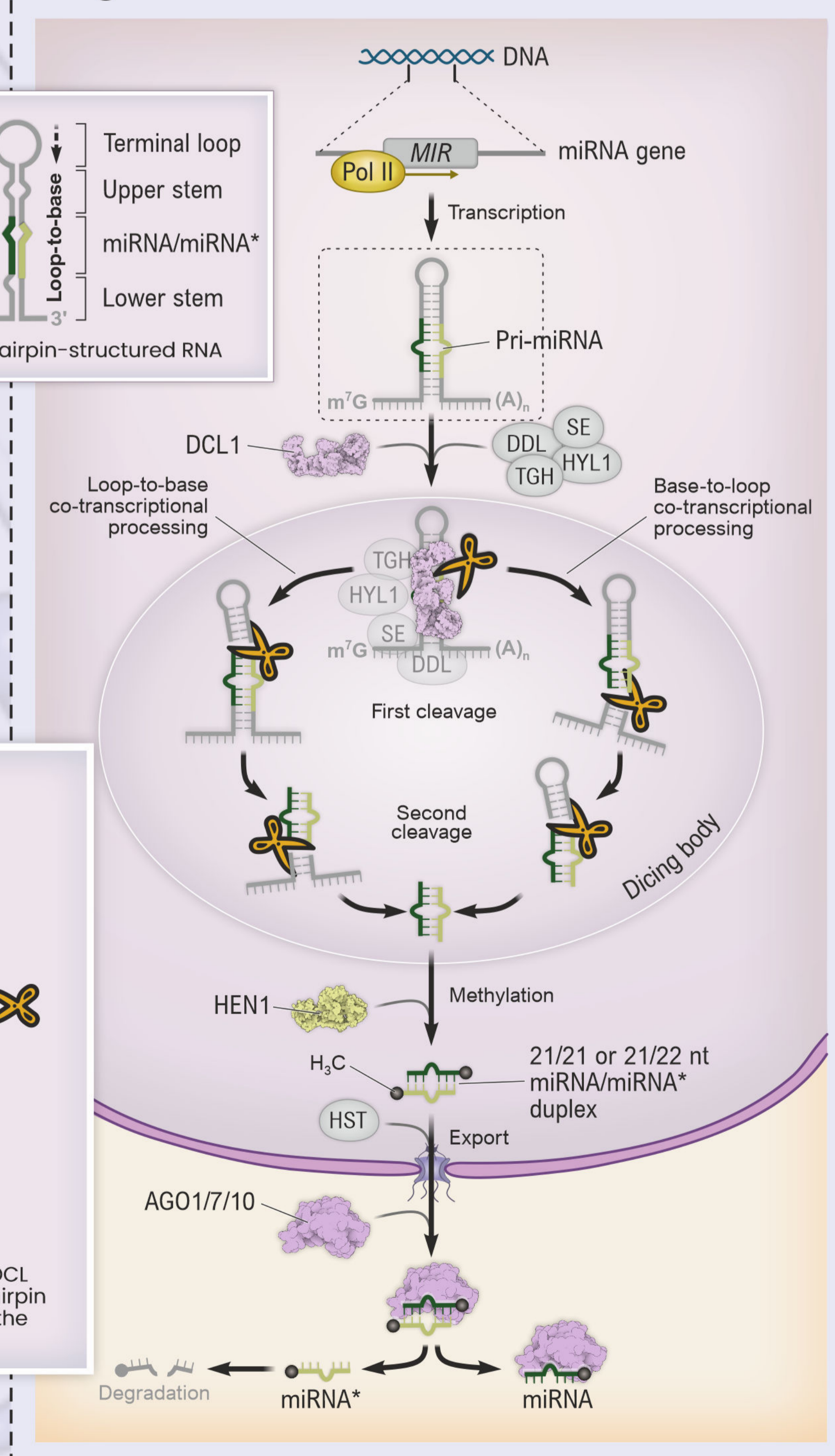
## Plant Small RNAs (21-24 nt) Silence Genes or Transposable Elements



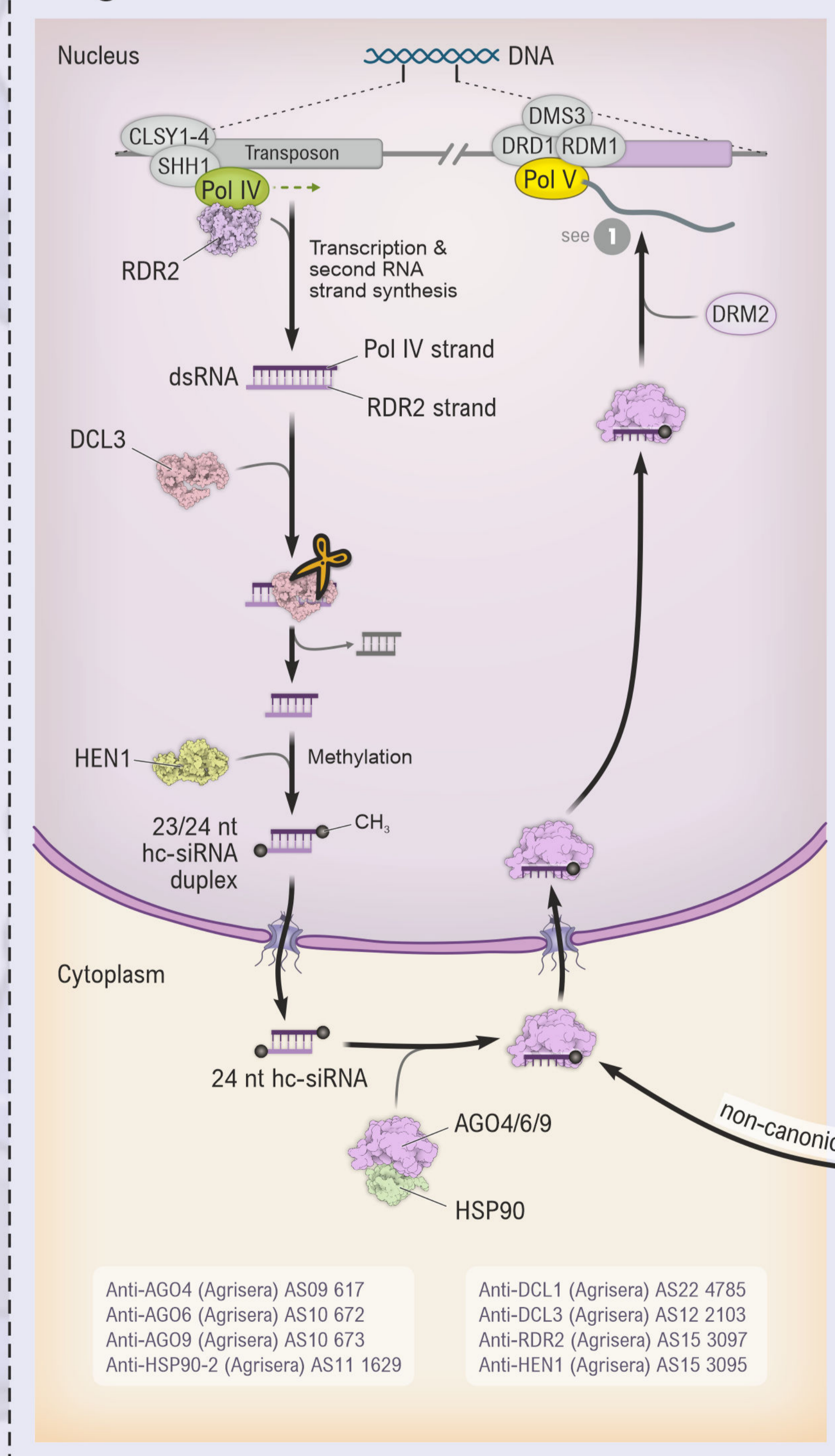
## Classification of Small RNA in Plants



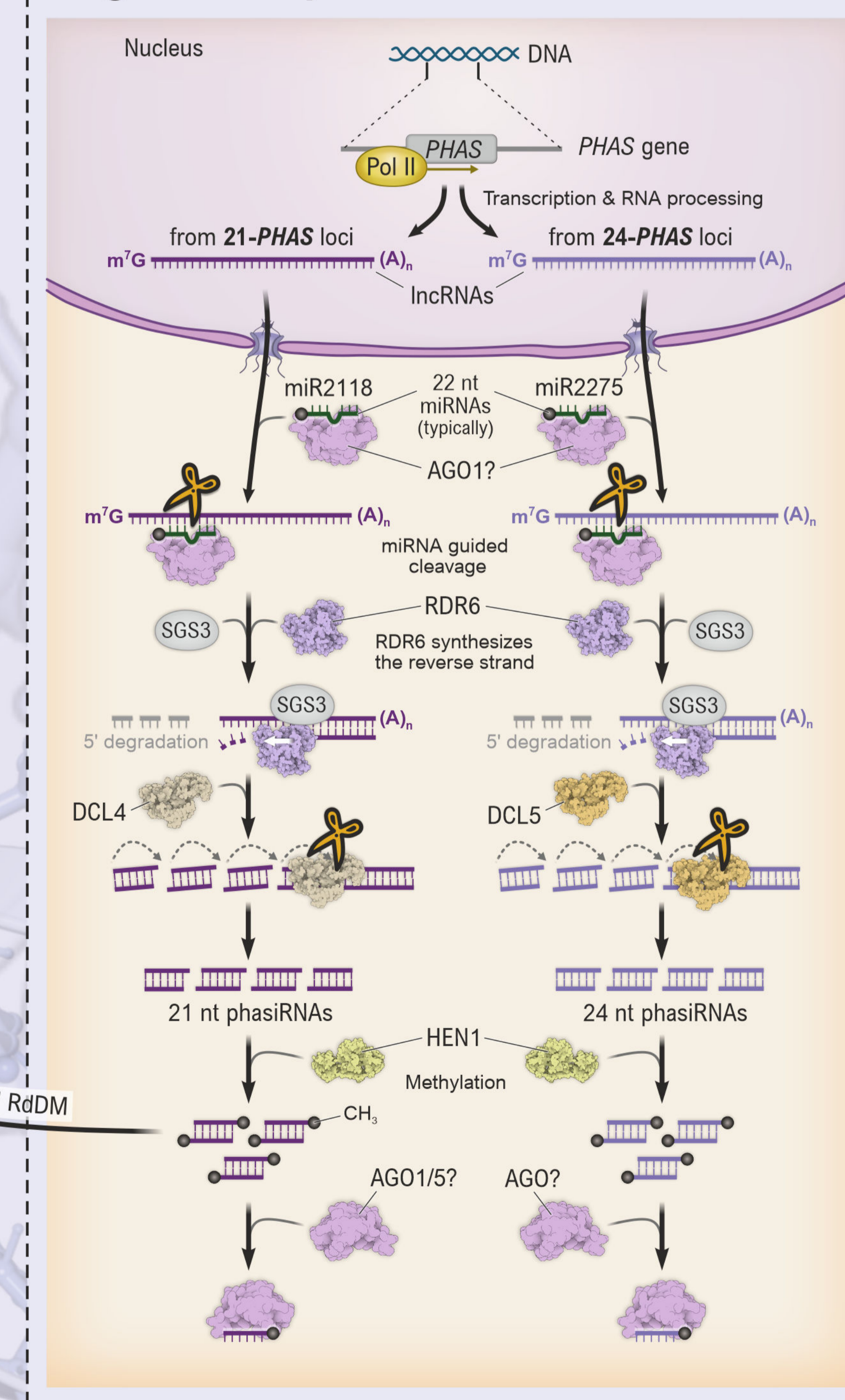
## Biogenesis of miRNAs



## Biogenesis and function of hc-siRNAs



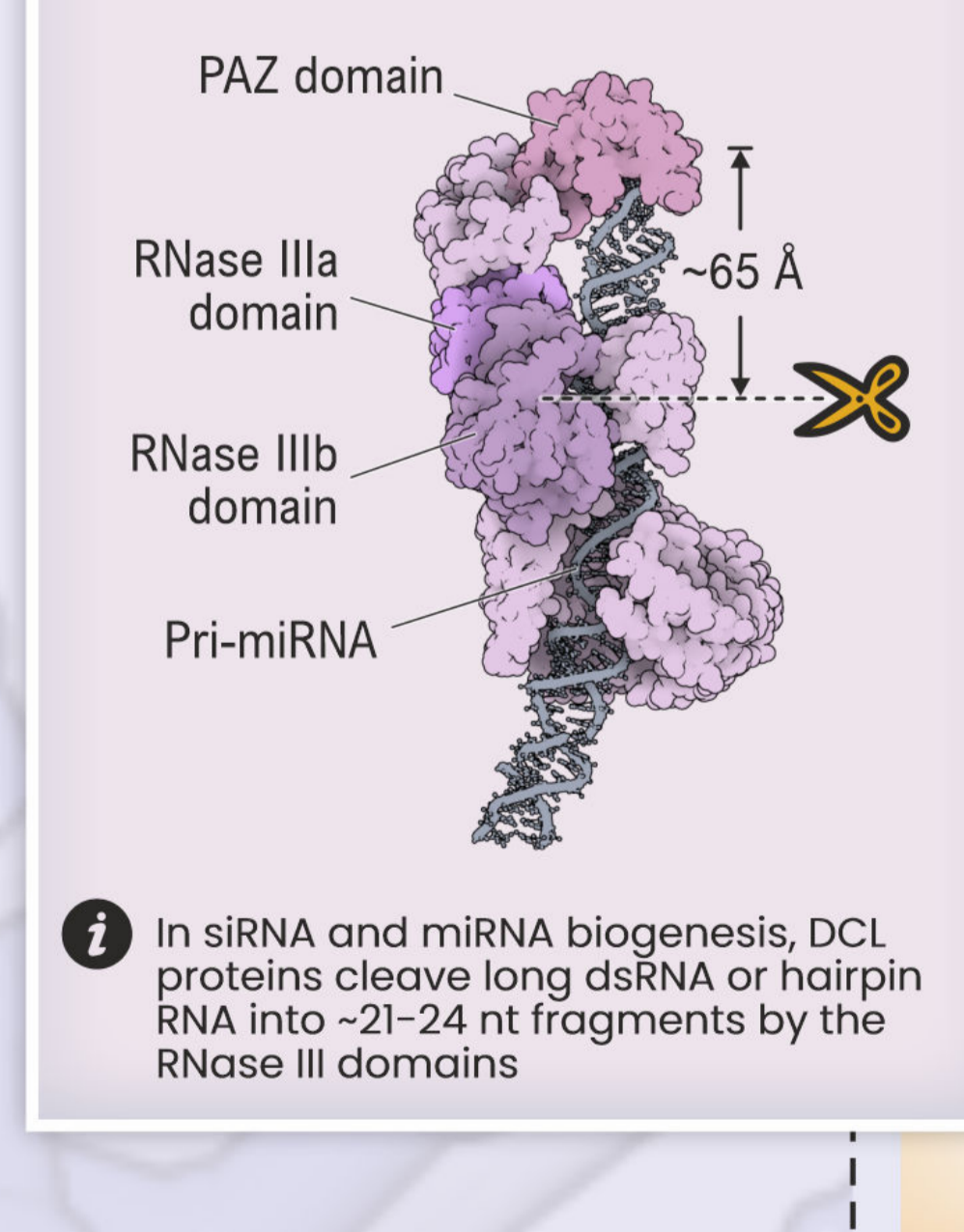
## Biogenesis of phasiRNAs



## miRNAs vs. siRNAs

Properties	miRNAs	siRNAs
<b>Origin</b>	Endogenous non-coding RNA. Distinct genomic loci. Encoded by their own genes ( <i>MIR</i> )	Exogenous double-stranded RNA. Encoded by transposons, viruses, and heterochromatin
<b>Precursors</b>	Hairpin-structured single-stranded RNA	Short or long dsRNA
<b>Structure</b>	21/21 or 21/22 nt miRNA/miRNA* duplex	21/24 nt long RNA duplex with a dinucleotide 3' overhang
<b>Target</b>	Homology-dependent pairing with Pol II products, with some mismatches allowed	Specific Pol II or unknown transcripts for phasiRNAs; Pol V transcripts for hc-siRNAs
<b>Role</b>	Endogenous gene expression regulator	Regulate genome stability via transposon suppression, plus viral defense and gene regulation

## DCL1 structure and function



## Poster 6 - Plant Small RNAs: Biogenesis and Functions, 2022

© 2022 Blake C. Meyers<sup>1,2</sup>; Junpeng Zhan<sup>1</sup>; Dmitry Shevela<sup>3</sup> & R. Keith Slotkin<sup>1,2</sup>

<sup>1</sup>Donald Danforth Plant Science Center, USA; <sup>2</sup>University of Missouri-Columbia, USA; <sup>3</sup>Umeå University, Sweden

**Agrisera**  
Antibodies

Plant antibody collection  
[www.agrisera.com/plant](http://www.agrisera.com/plant)

**Plant Meetings Calendar**  
Sign up your meeting, or check what is coming!  
<https://plantae.org/events-calendar/>

Graphics © Dmitry Shevela @ ScitGrafik

Agrisera holds exclusive rights for free distribution of this poster