Life Sciences

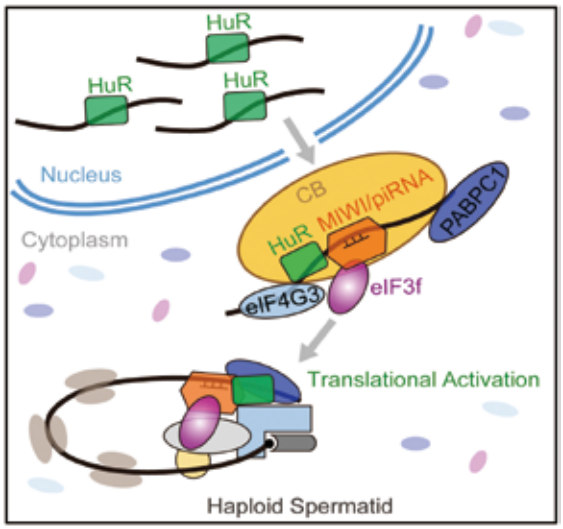
PIWI/piRNA Found to Play a Critical Role in Translation Activation during Sperm Formation

A joint team of scientists, consisting of groups respectively led by Dr. LIU Mofang at the Center for Excellence in Molecular Cell Science/ Shanghai Institute of Biochemistry and Cell Biology (SIBCB), Chinese Academy of Sciences (CAS), Dr. ZHOU Yu at Wuhan University, and Dr. SHI Huijuan at the Shanghai Institute of Planned Parenthood Research affiliated to Fudan University, recently reported that PIWI/piRNA plays a key role in translation activation during Sperm Formation. Entitled "A Translation-Activating Function of MIWI/piRNA during Mouse Spermiogenesis", this work was published online in *Cell* on Dec 12, 2019. Collaborators including Drs. LI Dangsheng, LI Jinsong and FU Xiangdong also contributed to the discovery.

The spermatid development, termed as Spermiogenesis, in mammals undergoes a series of dramatic morphological changes, which is programmed by a series of highly orchestrated regulatory events in gene expression at each developmental step. Due to chromatin compaction during the course of spermatid elongation, transcription becomes gradually inhibited during the spermiogenesis and then completely ceased later on. Thus, the program of spermiogenesis relies on gene products that are transcribed earlier and stored in translationally inert messenger ribonucleoproteins (mRNPs) until needed for translation. This phenomenon, known as uncoupling between transcription and translation, is a unique feature of gene regulation during spermiogenesis, which has been one of the major mysteries in understanding the germ cell development program.

The evolutionarily conserved Piwi proteins belong to the Piwi clade of the Argonaute family, each of which is specifically expressed during the development of animal germline. Piwi proteins are known to enlist germline-specific Piwi-interacting RNAs (piRNAs) to suppress transposable elements and protect the integrity of the genome in germ cells. In addition to their primary function in transposon silencing, the Piwi/piRNA machinery also mediates the degradation of a large set of mRNA transcripts via miRNA- or/and siRNA-like mechanisms in various animal germ cells.

Under the supervision of Drs. LIU Mofang, ZHOU Yu and SHI Huijuan, Drs. DAI Peng, WANG Xin, GOU Lantao, LI Zhitong, WEN Ze, CHEN Zonggui and their colleagues unexpectedly discovered that the mouse PIWI (MIWI)/piRNA same machinery is also responsible for activating the translation of a subset of spermiogenic mRNAs to coordinate with morphological transformation into spermatozoa. Such an action requires specific base-pairing interactions of piRNAs with target mRNAs in their 3′ UTRs, which activates translation through coupling with cis-acting AU-rich elements to nucleate the formation of a MIWI/piRNA/eIF3f/HuR super-complex in a developmental stage-specific manner. These findings reveal a critical role of the piRNA system in translation activation, which they show is functionally required for spermatid development.



The team revealed how the PIWI/piRNA complex regulate the translational activation in mouse sperm formation. (Image by SIBCB)

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