

Movie S1.

Confocal sections of a mouse GV oocyte expressing Mito-EGFP (mitochondria, green) and ZAR1-mScarlet (magenta). Scale bar, 10 μ m.

Movie S2.

Airyscan sections of a mouse GV oocyte expressing Mito-EGFP (mitochondria, green) and ZAR1-mScarlet (magenta). Scale bar, 10 μ m.

Movie S3.

Time-lapse movie of a mouse GV oocyte showing MARDO coalescence upon ZAR1 overexpression. MARDO, ZAR1-mClover3. Scale bar, 10 μ m.

Movie S4.

Time-lapse movies of mouse GV oocytes stained with TMRM. Scale bar, 10 μ m.

Movie S5.

Time-lapse movie of meiotic maturation of a mouse oocyte microinjected with 0.3 amol *Zar1-mScarlet* mRNA. Yellow, microtubules (mClover3-MAP4-MTBD); magenta, MARDO (ZAR1-mScarlet); cyan, chromosomes (H2B-miRFP670). Scale bar, 10 μ m.

Movie S6.

Time-lapse movie of meiotic maturation of a mouse oocyte microinjected with 3 amol *Zar1-mScarlet* mRNA. Yellow, microtubules (mClover3-MAP4-MTBD); magenta, MARDO (ZAR1-mScarlet); cyan, chromosomes (H2B-miRFP670). Scale bar, 10 μ m.

Movie S7.

Single molecule RNA FISH (smFISH) sections of a mouse GV oocyte expressing ZAR1-mClover3. Yellow, MARDO (ZAR1-mClover3); magenta, Alexa Fluor 647-conjugated *Elovl7* mRNA probes; cyan, Alexa Fluor 546-conjugated *Actb* mRNA probes. Scale bar, 10 μ m.

Movie S8.

Time-lapse movie of meiotic maturation of a *Zar1*^{+/+} oocyte expressing mClover3-MAP4-MTBD (microtubules, green) and H2B-mRFP (chromosomes, magenta). Scale bar, 10 μ m.

Movie S9.

Time-lapse movie of meiotic maturation of a *Zar1*^{-/-} oocyte expressing mClover3-MAP4-MTBD (microtubules, green) and H2B-mRFP (chromosomes, magenta). Scale bar, 10 μ m.

Movie S10.

Time-lapse movie of meiotic maturation of a *Zar1*^{-/-} oocyte expressing mClover3-MAP4-MTBD (microtubules, green) and H2B-mRFP (chromosomes, magenta). Scale bar, 10 μ m.