## **Supplementary Information For**

Vernalization-triggered intragenic chromatin-loop formation by long noncoding RNAs

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## This includes:

Supplementary Table 1 Supplementary Figs. 1 to 6

## **Supplementary Table 1. Related to Figures 1 ~ 6 and Supplementary Figures S1 ~ S6.** Sequence information of primers used in this study.

FLC     gecanageagecapacterity     cancepc apting getter (sequence)     QRT-PCR       PP2A     tatege generative (sequence)     QRT-PCR     QRT-PCR       FT     ggaacaaccuttge (sequence)     gettge (sequence)     QRT-PCR       COLAIR     (getagge (sequence)     getage (sequence)     QRT-PCR       COLDWR AP     (getagge (sequence)     getage (sequence)     QRT-PCR       COLDWRAP     gegaaagatagitteatting (secal gegaege) (sequence)     QRT-PCR       COLDWRAP-Full     aggeaacge (sequence)     RNA ioning assay       COLDWRAP-Full     aggeaacge (sequence)     RNA holding assay       COLDWRAP-Full     aggeaacge (sequence)     RNA holding assay       COLDWRAP-Full     aggeaacge (sequence)     RT-PCR       Bageaccoccup (sequence)     get(sequence)     RT-PCR       PS     atgegaacge (sequence)     RT-PCR       PC-P1     (sequence)     get(sequence)     RT-PCR       PS     atgegaaccoccup (sequence)     get(sequence)     RT-PCR       PLC-P1     (sequence)     get(sequence)     RT-PCR       PLC-P3     accaccoccup (sequence)     get(sequence)	Name	Forward	Reverse	Use
PP2A     Integradagantuccingpag     general excittige calating and the class of the clas of the clas of the class of the class of the class of the clas	FLC	gccaagaagaccgaactcatgttga	caaccgccgatttaaggtggcta	qRT-PCR
FT     ggaacaacttiggenatgagat     ctgcongegtegaacaa     qRT-PCR       COULAIR     tigtagetecticacttegica     gccgraggetegicactagi     qRT-PCR       COLDAIR     ggacacagetegicactagia     agnacactacaccagitacantitigac     qRT-PCR       COLDWRAP     aggacagatagittetticatticacaccagitticacttigac     qRT-PCR       COLDWRAP-KD     cacagetegecagitticcentaga     RNA ionstruct       COLDWRAP-Full     aggaacgitagetitactticacacgaagit     enageteceggtitaccentaga     RNA inding assay       COLDWRAP-Full     aggaacgicagetageagaagatagetitactageacagit     gtftgttttgaagacaagatageacacg     RT-PCR       COLDWRAP-FILL     aggaacgicaggacagaaaaaactagaacagaagtag     gtftgttttgaagacaagatageacag     RT-PCR       P8     atggaacaaacaatageagaatagatage     gtftgtttttgaagacaagaagatageaga     RT-PCR       RC-P1     cfgtgattgccgcccggactgaacca     ChIP     RT-PCR       RLC-P2     ctaftatcccggcactgaatagagattgcca     GLIP     ChIP       RLC-P3     accaactttggettgccattagag     ggttgcctaatagagattgccacg     ChIP       RLC-P4     ggaaagtgattgtttttttttiggaccatagattggttggttggaagattg     ChIP     RIP       P2A     agcctatagegttggttgaaagcctcggacagaagattggttggttggaag	PP2A	tatcggatgacgattcttcgtgcag	gcttggtcgactatcggaatgagag	qRT-PCR
COOLARIpringingtuccucationgecingcontractingqRT-PCRCOLDARggcoccecopic getrage transmissionagtagacacteraccaganteratingqRT-PCRCOLDWRAPaggeangangtucatingtageanggagarcagacgetingcoctingtagangqRT-PCRCOLDWRAP-FDIaggeangangtucatingtageanggacriggtoccecopicatingtacteragingqRT-PCRCOLDWRAP-FDIaggaangangtucatingtageanganggacriggtoccecopicatingtacteragingRNA biomismutCOLDWRAP-SRACEgaangtgaanactaggcangcanaggaagtiggtingangcangatingcacagRNA biomismusCOLDWRAP-SRACEgaangtgaanactaggcangcanaggaggtiggtingangcangangtigacagRA biom probeP5gaangtgaanactaggcantgacagaangtgtiggtingangcangangtigacagRT-PCRP8digggaagaaaanactagaacagcagaatigggcacaacaacticaaagactigacRT-PCRP1C-P2citagiatcecoccegiggistinggggcacaacacacticaacagactigacChIPFLC-P3citagiatcecoccatiggistinggggtgcacataacticaacagatigChIPFLC-P4gtgaanaccatigaatingistinggetgetgcacacacacticaagaacgaacChIPA6gtgaaaacaatitocitagaatiggetgetgcacatingacceChIP & RIPP2AagcattigcacacacatiggtfgtffffffangacaagatigcacChIP & RIPP2AagcattigcacacagatiggtfgtffffangacaagatigcacacaRIPBcitagtatcecegegaattataccaagatigggtgtcatattigcacagatigRIPCtacaaccetceantatatataccaaagigggtgtcatattigtaggaagatigcacaRIPBcitagtatcecegegaattatatagtattiggacaGCGCAaggaaagaagattattitattiggacaagattaggaagatGC <td>FT</td> <td>ggaacaacctttggcaatgagat</td> <td>ctgccaagctgtcgaaacaa</td> <td>qRT-PCR</td>	FT	ggaacaacctttggcaatgagat	ctgccaagctgtcgaaacaa	qRT-PCR
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COLDWRAP     aggaagangtitticattingeaacgaagig     geagaggettittigeattingeattiggaag     qRT+PCR       COLDWRAP-KDI     cascnagaagtagtitticattingeaacgaagtig     cingtgeccecigtaacgeatagtig     RNA ionstruct       COLDWRAP-FIAI     aggaagangtitticattingeaacgaagtig     cingtgeccecigtaacgeatagtigea     STRACE       COLDWRAP-FBLUE     agagtecagagagaagtigagticattingeacgigt     gradingeagagagagatigtitticattingeacgigt     RNA binding assay       COLDWRAP-STRACE     gaaagtigaanaactanggeatageaanggigtig     gittgittingaacaagtittigeacgigt     RNA binding assay       PS     gaaagtigaanaactanggeatageaanggigtig     gittgittingaagaaagtitgaactittig     ChIP       FLC-P1     cittginatecgeggaattingac     ggetecnaaggaagaagtigtaactittica     ChIP       FLC-P2     cittginatectittittigting aggicacactaacticangaagtigta     ChIP       FLC-P3     accaacctittitticcitagaattitticgicacg     ggetystergeggaaatatagecca     ChIP & RIP       PD4     gigaaagattittictittigeacaattitticgicacg     ggetystergeggaaattagaattitticgicacg     ChIP & RIP       B     citagaaattittictittigeacgaattitticgicacg     ggetysterattittiggaagacticagaattitticgicacggiggaagacticac     RIP       D     ggaaagaagattitticattitticgicacg     ggetystattittittiggaagacticagaattittittiggaagacticagaactitti	COLDAIR	ggccacgcgtcgactagtac	agtagacactacaccagattcaattttgac	qRT-PCR
COLDWRAP-KD     cacagaaagangutticattagcacgaagug     caagattgcccggtagc     RNA iconstruct       COLDWRAP-FixCE     aggaaagangutticattagcacgaagug     cittigscctaattigstcccaggtag     RNA binding assay       COLDWRAP-FixCE     aggatagaaacttagcacagtagugcacgaaagug     gttigsttringsaccaagutcgccg     S'RACE       COLDWRAP-PBLUE     aggtacgegggtaacgagagugcacaaaaa     gttigsttringsaccagattgccagg     R'N binding assay       COLDWRAP-PBLUE     aggtacgegggtaacagaagtgcc     gttigsttringsaccagattgccagg     R'N-PCR       PS     gtaagtgaaactaaggaattgaca     gttigstringsaccagattgccag     R'N-PCR       PS     gtaagtgaaactaaggaattgaca     gttigstringsaccagattgccag     ChIP       FLC-P1     cgtgaattggatttgacctagattgaca     gctfccaaggaacagaatgcag     ChIP       FLC-P3     accacactttgattggattgacc     ggtgctaattggagagtcaca     ChIP       AG     gtggaaagtatttigacttagattggattgaca     ggtggtgaagtccataaattgggagtaca     ChIP & RP       P2A     agcsttitacccgaattggtg     gttgtttigaagacatagtcccgtg     ChIP & RP       P2A     agcattgtactggtggattgcacagattgg     gttgtttigaagacagattgccaggt     ChIP & RP       P2A     agcsttitaccgaattggttgtgtattgacagagtgtcacagattggg     GC     <	COLDWRAP	aggaaagatagttttcatttagcaacgaaagtg	gacgagcgtctttgctacttttgcattg	qRT-PCR
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COLDWRAP-SYRACE     gaaagtgaanstraaggcantgcanagtage     gitggtttgaagcaaggalgatgutcaagaa     gitggtttgaagcaaggalgatgutcaagaa     gaagtccaggaagalgutcaagaag     gitggtttgaagcaaggalgutcaagaag     gaggccagaaagalgutccacag     RNA blot probe       P5     gaaagtgaanaaaacagcaatgcaaggalgutcaagaag     gttggtttgaagccaaggaagtcccag     RT+PCR       P8     atgggaaganaaaaacaggaagtgutcaagaag     gttggtttgaagccaaggaagctgac     RT+PCR       P1C-P1     cttagtatctccgccgattgaac     gggacaaaccaaactacaacgaatcaaagtga     ChIP       FLC-P2     cttagtatctcggcagatgaacg     ggtggtaalaaggatgac     ChIP       FLC-P4     gtgaantgtgattgactagaattgaaggatgac     ChIP       AG     gtgaaagttgaactaggatgacgaaggatgac     ChIP       AG     gtgaagttgaactaggatgacgaaggatgacgaaggatgac     ChIP & RIP       P2A     agcttfaacccattrgtgtgttatg     ccttctccaaggacgaagtgaggatga     ChIP & RIP       P2A     aggaagtagttttattagcaaggaagt     gttgtttttgaggcaaagatg     RIP       B     cttagtatcctggtgtatggacgaagatg     ccttrtctaaggeagtcgaagatgagaggacga     RIP       D     gggaagtagattgtttgaactaggatggacgaagatg     RIP     G       C     ttagtatctcagggaagtgacaagatgga     RIP	COLDWRAP-Full	aggaaagatagttttcatttagcaacgaaagtg	ctttgtgccctaatttgatcctcaggtttg	RNA binding assay
COLDWRAP-pBLUE     aggstaccggggstaacgaaggagtgatgcaaaaaa     agagstcaggaaagatagtttcatttagcaacg     RNA blot probe       P5     gaaagtgaaactaaggcaatgcaagtag     tigtgttttigaagcaaggtigcoc     RT-PCR       P8     atgggaagaaaaaattaggaattag     tigtgtttigaagcaaggtigcoc     RT-PCR       FLC-P1     cgtgagtccggccctgatagc     gggacaaaccaaacctaccaagaactig     ChIP       FLC-P2     cttagtatcccggcgactgaac     gegtgcaaagaacagaagattgg     ChIP       FLC-P3     acacacttgtatcttigttigttig     agttggaagtagggaagtcac     ChIP       AG     ggaataggtagttigtcattggtact     agttggaagcacggaaccata     ChIP & RIP       AG     gggaaggaagaattcgaacgaagtg     gttggtttggacattagcc     ChIP & RIP       PDA     agcctatatccgaattagcacgaagtg     gttggtttggacaagtccggg     ChIP & RIP       PDA     aggstagattgttcattagcacgaagtg     gttggtttgagacacggag     ChIP & RIP       GC     tagaactattagtatacctaagtgttg     cacettctaaaggctgaagtcacg     RIP       GC     tagaactattagtatacctaagtgttg     Gc     GC       GC     tagaagtagatttgatactagtgtgagaccaag     GC     GC       GC     tagaagttgaattttgatgaagtgtggagacca     GC	COLDWRAP-5'RACE	gaaagtgaaaactaaggcaatgcaaaagtagc	gttgtgttttgaagacaagattgccacg	5'RACE
P5     gaaagtgaaaactaaggcaatgcaaagtagc     gttgttttgaagcaagatgcacg     RT-FCR       P8     atgggaagaaaaaaactaaggcaatg     tgcgtcacgaagaacgaaagctagc     RT-FCR       P8     atgggatgaaaaaaactaaggcaatg     tgcgtcacgaagaaagctagc     RT-FCR       P8     ctagatactceggergaage     ggatcacaaccacaaccaaccaagattic     ChIP       FIC-P2     ctagatactceggergattgaac     ggtggcaatcaaccaggaagattag     ChIP       FIC-P3     accaaccttggattagtattgtact     ggtggcaatcaaccaacctacaagattagattaggtggagatcac     ChIP       AG     ggaaagtggaagctcegaaccacteg     agtgcttgcgcgcgaaaataagcc     ChIP & RIP       D4010     aggtggaaagctcgaaccateg     agtgcttgtgccggcgaaaataggcc     ChIP & RIP       R     aggaagatgtgtgtttagcgaagttggacg     cctctcctcaaggacgagaa     RIP       B     cttgatactceggcgaaagttgaccaagggc     RIP     RIP       C     tacaaccctccaatagattggtcgaagttgaccaagggc     RIP     RIP       C     tacaacctccaatagattagtagtggc     3C     3C       3C-F1     cgtgaatagtgttgaccaaggattggaag     3C     3C       3C-F3     ggtcttgatacgattggttgaccaaggattggaag     3C     3C       3C-	COLDWRAP-pBLUE	aaggtaccgggggtaaacgagagtgatgcaaaaaaa	aagagctcaggaaagatagttttcatttagcaacg	RNA blot probe
P8     atggnagaaaaaactagaaacaagaactagaagt     tgcgtaccagaaaaagtgacg     RT-PCR       FLC-P1     cgtgaqtecgecceqatage     ggaccaaaccaaacchaaagttu     ChIP       FLC-P2     cttgattetcgeggeattgaace     ggtgcaaagtaagattga     ChIP       FLC-P3     acaaacctttglatttigtettitg     aghgacatcaaccacagattcaattigae     ChIP       FLC-P4     gfgaatagtjauttgactagaattalcagtaag     ggtgcaaattagtagggagatce     ChIP & RIP       AG     ggtgaaagticcgaaattace     agtfgaatagtfuttagecaattaattattuttgaggaangtace     ChIP & RIP       PPAA     agctgtaaacatttrectgeaagtge     ggtfgtfgtgggaagatce     ChIP & RIP       PPAA     agctgtaaacatttrectgeaagtge     ggtfgtfgtgggaagatce     RIP       B     cttagtateccgggegaattaacc     ggtfgtgtgggaagatce     RIP       C     tacaacceccaattataaccaaagtgg     ggtfgtgaaggagatca     RIP       GC-F1     catgaaaatcattggregatcaaattagggg     3C     3C       3C-F3     ggtfgtgaattafaattafaatagaaggaattggg     3C     3C       3C-F4     cggttttgatafactagagattgaagtaggaggaagatag     3C     3C       3C-F5     cettttagttictcgggegaattagaattgatggg     3C     3C <tr< td=""><td>P5</td><td>gaaagtgaaaactaaggcaatgcaaaagtagc</td><td>gttgtgttttgaagacaagattgccacg</td><td>RT-PCR</td></tr<>	P5	gaaagtgaaaactaaggcaatgcaaaagtagc	gttgtgttttgaagacaagattgccacg	RT-PCR
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FLC-P3acacaactitgiatetigigettiligagingacatacaccagatteautigneChIPFLC-P4gigaatagitgattigactigatategineaggigigetattatagitegiggagetacaChIPAGgigaacaattecicgeagatigetactagitiggaaaattaccicgeagatigetacaChIP & RIPUBQ10aggiggaaagateciggeaattaccicgaaagategaagetagaaagatagitticattagitegiggaagatagategageChIP & RIPPPAAagecuttatacccgatigetiggetatacgeciteciccaagaagacagageChIP & RIPAaggaaagatagitticattagaccagaagggitiggittigaagacagaagategacaggeChIP & RIPBcitagtatccicggegaetigaacgecitecicagaagacagaagetgaRIPCtacaaccicciccaattatataccaaatgigtigcacgitticaaaaggetictictitataaataRIPDgigaatagigattiggatacaattiggeg3C3C3C-F3ggiteingataccaattiggengecaanaattitigge3C3C3C-F4cgcittattictigtegictittictittitaga3C3C3C-F7gaagagatatatatacacagacaagacagaacagaacag	FLC-P2	cttagtatctccggcgacttgaacc	gcgtcacagagaacagaaagctga	ChIP
FLC-P4     gtgatagtgattitgacctagtattagtacag     ggtggtattatagtagtggaggtaca     ChIP       AG     gtgaaacaattitcctgcagattgtact     agttitgggggagtaca     ChIP & RIP       UBQ10     aggtggaaagtcccgatccatcg     agttitggggcataataagttigtaatt     ChIP & RIP       PP2A     agccattaaccatcg     agttitggggcataataagttigtaatt     ChIP & RIP       A     aggaagatagttitcattagcacacaagagt     gttggttitgagaacaagaagtagtticattagtacacgaagt     RIP       B     cttagtatctcggcgacttgaacc     ggtgctaattaagtaggtggaggtaca     RIP       C     tacaacctccaattaataaccaatggtg     ggtggtgaaggacagaaggtag     RIP       3C-F1     cagaaattattigtgtagtttggccaaagattggg     3C     3C       3C-F3     ggttagattggtaggcaaagattggg     3C     3C       3C-F4     cgcttattatccaggcactaagattggg     3C     3C       3C-F5     cctttattattattacaagattagttattgg     3C     3C       3C-F1     gaagagttaattatataaaattagtat     3C     3C       3C-F5     cctttattgggaattggaaattgaaattagtattggt     3C     3C       3C-F10     cagcttggaaattgaaatccacaca     3C     3C       3C-F11     gctcttatggaattgaa	FLC-P3	acacaacctttgtatcttgtgtcttttg	agtagacactacaccagattcaattttgac	ChIP
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UBQ10     aggtggaagetccgacaccatcg     actgttgtcgggggaaagataget     ChIP & RIP       PP2A     agcattatacccgattgtgtgttatcg     ccttctctccaagagcagge     ChIP & RIP       B     aggaaagatgttttattatatagacacgaagtg     gttgttfffgaagacagaatggcacgtga     RIP       C     tacaaccctccgergattgaacc     gcgtacagaatggaagatgtttcattataataacaaatggtg     cacgttctaaaaggottctttttataaatc     RIP       D     gfgaataggattfgecaagaatggtggcaagaatggaaggcac     RIP     3C       3C-F1     catgaaaacattfggetgactacattattutggg     3C       3C-F3     ggttgtataccagggtggcaagattggcaaggtgg     3C       3C-F4     cgcttatatcgggtggcaagataggtatgcaagattggg     3C       3C-F5     ccttttatcttgtttgtgctttttatttticgg     3C       3C-F8     cggattgtatgcaatgcactaggg     3C       3C-F1     gcaagagtttatatataataaattgg     3C       3C-F8     cggattgtaagaatgcaagatgatgtt     3C       3C-F10     cacgtccgggaattgaaatcccaaca     3C       3C-F17     ctgtctttacgaattgtgaattgtage     3C       3C-F10     ttgttttacgtcaattcgaagtgtgtttttage     3C       3C-F11     gcctctaggaattgaagttaccaattgggttttttgge     3C	AG	gtgaaacaaattttcctgcagaatgtcact	agtttttgaggcactaaaatctttgggtaaatc	ChIP & RIP
PP2A     agccittataccgattgctgtctatcg     ChIP & RIP       A     aggaagatagttitteattagcaacgaagtg     gttggttttgaagacagatgcccetgg     RIP       B     cittagtatciccgggggttggaacc     gcgtacacgagaacgaggctctcittatataata     RIP       C     tacaccciccatadtaataacaaatggtg     gcgtacacgagaacgaggcttcittatataata     RIP       D     gtgaatagtgattitgacctatgatatcgtacg     ggtggctaattagagggggtctittittatata     RIP       3C-F1     catggaaaatcattggtagcaagaattggg     3C     3C       3C-F2     cgttagaatcgatggaacaagattggg     3C     3C       3C-F5     cctittatcictgttitggcattacca     3C     3C       3C-F7     gaagagttaattatatatacaagaacatagtatatgt     3C     3C       3C-F8     cggattigtagcaatggactaaggattggt     3C     3C       3C-F11     gcctctaggaaattgaattatgt     3C     3C       3C-F7     gaagagttaattatatataagagctaagctatggt     3C     3C       3C-F11     gcctctaggaaattgaattggtgtttatgaatggt     3C     3C       3C-F13     gcaaggtgtaattggtgttttagaatggtgtgtaaccaag     3C     3C       3C-F19     tatgttttggaatgcaattggagttggtgtgtgtgtgtgt	UBQ10	aggtggaaagctccgacaccatcg	agctgcttgccggcgaaaataagcc	ChIP & RIP
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3C-R11   gacactacaccagattcaatttgacaacttatatat   3C     3C-R13   cttccatagaaggaagcgactaagacag   3C     3C-R15   ctaattgcaacctcatcagagattcagagctcc   3C     3C-R17   gtagctcatagtgtgaaccatagttcagagc   3C     3C-R19   cctggttcttttctagcaatttctcctg   3C     3C-R20   gcactactctacagaagtgagtggaac   3C     3C-R21   gggaaaaaagaagtgttacgattgggaac   3C     3C-R22   ggtcaggtgaagtgatagtgtagcacttgtg   3C     PP2A-LC   Ctctctagattgggacggcacaaagttc   ctcaattccgcctctgagatattcaaagg   3C     P1   TAACTTTGAGCTATTGCCATATGTG   ATAGTAAAAACAAAGAACCAC   Tiling PCR     P2   TGTGTTAATCTCCCCGAACATTATTA   GTAGACATATCGAAACCTAAA   Tiling PCR     P3   TGTAGGCACGACTTTGGCAACAC   TTTTCACTTTCGTTGCTAACAT   Tiling PCR	3C-R9		gtatatatacattgttcagcattaaccccatagcaa	3C
3C-R13   cttccatagaaggaagcgactaagacag   3C     3C-R15   cttaattgcaacctctatcagagattcagagctc   3C     3C-R17   gtagctcatagtggaaccatagttcagagc   3C     3C-R19   cctggttetettettettagcaatttecegag   3C     3C-R20   gcactacttetagacattggagtggaac   3C     3C-R21   gggaaaaaagagtgttatcattatataaatgtg   3C     3C-R22   ggtcagtgtaagtgtaggattegcattggg   3C     PP2A-LC   Ctectagattgggacggcacaaagtttc   ctcaattccgcetctgagataattcaaagg   3C     P1   TAACTTTGAGCTATTGCCATATGTG   ATAGTAAAAACAAAGAACCAC   Tiling PCR     P2   TGTGTTAATCTCCCCGAACATTATTA   GTAGACATATCGAAACCTAAA   Tiling PCR     P3   TGTAGGCACGACTTTGGTAACAC   TTTTCACTTTCGTTGCTAAATG   Tiling PCR	3C-R11		gacactacaccagattcaattttgacaacttatatat	3C
3C-R15   ctaattgcaacctctatcagagattcagagctcc   3C     3C-R17   gtagctcatagtggaaccatagttcagagc   3C     3C-R19   cctggttcttttcttcagcatttcccgg   3C     3C-R20   gcactacttctagacattggagtggaac   3C     3C-R21   gggaaaaaagagtgttatcattataaatgtg   3C     3C-R22   ggtcaggtgaagtggacggcacaaagttc   3C     PP2A-LC   Ctctctagattgggacggcacaaagttc   ctcaattccgcctctgggataattcaaagg   3C     P1   TAACTTTGAGCTATTGCCATATGTG   ATAGTAAAAACAAAGAACCAC   Tiling PCR     P2   TGTGTTAATCTCCCCGAACATTATTA   GTAGACATATCGAAACCTAAA   Tiling PCR     P3   TGTAGGCACGACTTTGGCAACAC   TTTTCACTTTCGTTGCTAAATG   Tiling PCR	3C-R13		cttccatagaaggaagcgactaagacag	3C
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3C-R20   gcactacttctagacacttggagttggaac   3C     3C-R21   gggaaaaaagaagtgttatcattatataaatgg   3C     3C-R22   ggtcaggtgaagtgtaagtgtacgcattgtg   3C     PP2A-LC   Ctctctagattgggacggcacaaagttc   ctcaattccgcctctgagatatcaaagg   3C     P1   TAACTTTGAGCTATTGCCATATGTG   ATAGTAAAAACAAAGAACCAC   Tiling PCR     P2   TGTGTTAATCTCCCGAACATTATTA   GTAGACATATCGAAAACCTAAA   Tiling PCR     P3   TGTAGGCACGACTTTGGCAACAC   TTTTCACTTTCGTTGCTAAATG   Tiling PCR	3C-R19		cctggttctctttcttcagcattttctcctg	30
3C-R21 gggaaaaaagaagagtgtatatatataaaatgg 3C   3C-R22 ggcaagtgtaagtgtatcgcatcttgtg 3C   PP2A-LC Ctctctagattgggacggcacaaagttc ctcaattccgcctctgagataattcaaagg 3C   P1 TAACTTTGAGCTATTGCCATATGTG ATAGTAAAAACAAAGAACCAC Tiling PCR   P2 TGTGTTAATCTCCCGAACATTATTA GTAGACATATCGAAACCTAAA Tiling PCR   P3 TGTAGGCACGACTTTGGTAACAC TTTTCACTTTCGTTGCTAAATG Tiling PCR	3C-R20		gcactacttctagacacttggagttggaac	30
3C-R22 ggtcaggtgtagtgtagtgtacgcatcttgtg 3C   PP2A-LC Ctctctagattgggacggcacaaagtttc ctcaattccgcctctgagataattcaaagg 3C   P1 TAACTTTGAGCTATTGCCATATGTG ATAGTAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA	3C-R21		gggaaaaaaaaaagagtgttatcattataaaatoto	30
PP2A-LC Ctctctagattgggacggcacaaagtttc ctcaattccgcctctgagataattcaaagg 3C   P1 TAACTTTGAGCTATTGCCATATGTG ATAGTAAAAACAAAGAACCAC Tiling PCR   P2 TGTGTTAATCTCCCGAACATTATTA GTAGACATATCGAAACCTAAA Tiling PCR   P3 TGTAGGCACGACCTTTGGTAACAC TTTTCACTTTCGTTGCTAAATG Tiling PCR	3C-R22		ootcagototaaototatcgcatcttota	30
P1     TAACTTTGAGCTATTGCCATATGTG     ATAGTAAAAACAAAGAACCAC     Tiling PCR       P2     TGTGTTAATCTCCCGAACATTATTA     GTAGACATATCGAAACCTAAA     Tiling PCR       P3     TGTAGGCACGACTTTGGTAACAC     TTTTCACTTTCGTTGCTAAATG     Tiling PCR	PP2A-LC	Ctetetagattgggaeggeacaaagttte	ctcaattccocctctoagataattcaaagg	30
P2 TGTGTTAATCTCCCGAACATTATTA GTAGACATATCGAAACCTAAA Tiling PCR   P3 TGTAGGCACGACTTTGGTAACAC TTTTCACTTTCGTTGCTAAATG Tiling PCR	P1	TAACTTTGAGCTATTGCCATATGTG	ATAGTAAAAAACAAAGAACCAC	Tiling PCR
P3 TGTAGGCACGACTTTGGTAACAC TTTTCACTTTCGTTGCTAAATG Tiling PCR	P2	TGTGTTAATCTCCCGAACATTATTA	GTAGACATATCGAAACCTAAA	Tiling PCR
	P3	TGTAGGCACGACTTTGGTAACAC	TTTTCACTTTCGTTGCTAAATG	Tiling PCR

P4	CATAGTTCAAAGATGATGTAGAGT	GCAAAAAAACCAAATATGTGA	Tiling PCR
P5	ACTAAGGCAATGCAAAAGTAGCA	TTCCTTTTCTCGCTTTATTTCTT	Tiling PCR
P6	CATCACTCTCGTTTACCCCCA	TGGCTTCTCTCCGAGAGG	Tiling PCR
P7	AAAAAAAAAATAGAAAGAGAAAA	TGACGAGCTTTCTCGATGAGA	Tiling PCR
P8	ATGGGAAGAAAAAAACTAGAAAT	AAAAGGCGTACTTATCGCCGG	Tiling PCR
Р9	AGCTTTCTGTTCTCTGTGACG	AACCAAACGGTATATTAATTGT	Tiling PCR
P10	TCCTTACCTGGGTTTTCATTTGTTC	GTTCTTCCTTAAATTTGGTTAT	Tiling PCR
P11	TTTTTCCGGCGGATCTCTTG	TTCCAAGGAAATAATGAAATC	Tiling PCR
P12	CAATGTCGTGAAGAAGCTTTTTAG	CTAAAGGTAAGAAACAATCAA	Tiling PCR
P13	AAAAAATTGCATGTCATTCACGAT	ACAAATCCGAGAGATCCAATG	Tiling PCR
P14	GAGATTCCTTAAGTTTTTGAAGAG	ATAGTCTTATATAGTCAATAGCT	Tiling PCR
P15	TATGCAATGCACTTACGGGAG	CTACTGTGTATGAAAAATATGA	Tiling PCR
P16	TTGTTAATCTTCTATGAATTCCTAT	AAAGAATCGCAATCGATAACC	Tiling PCR
P17	GTTTTGAATTTTGGTAGCTTCAAA	ACAAATCCAAGAGAACAATGA	Tiling PCR
P18	TGAATCACAATCGTCGTGTGCTAT	TTCCCAATTAATGTGGCTTACA	Tiling PCR
P19	tatatgcacgtccgggagatttataaataaa	ATAAACCTTTGGACAATCTTTA	Tiling PCR
P20	AACTATGACTAAAAGATGAATTGG	TAAATGAACACAACGATGATA	Tiling PCR
P21	TAGTTTCCCACTCTTGCAGTTACA	TGACAAAAGACACAAGATACA	Tiling PCR
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P23	ACACAACCTTTGTATCTTGTGTCTT	AGTAGACACTACACCAGATTC	Tiling PCR
P24	CTTCATGTAAGAAATACCAACCTC	CAAATCCTAACAAAGTATGCAT	Tiling PCR
P25	TACAACCCTCCAATATAATAACCA	CACGTTCTAAAAGGCTTCTTCT	Tiling PCR
P26	CAAGTGGGGATCAATCCAGG	ACTTAATTTGTTTGTTAATAG	Tiling PCR
P27	GAACCCTTAGTTACTCAGTTACTC	CATATCTATAAATATATCTTCCA	Tiling PCR
P28	ACTTCAAAACAGTTTTAACAACCT	CAATTTCCTATATTTAAACCCC	Tiling PCR
P29	GTGTGATAAGTTTCCTACTAATATT	TTTTTTTGCAAATATCAAAAG	Tiling PCR
P30	GGAACCTCACAGTTTCTATAAACG	GATGTGGCGGTAACCAGATAA	Tiling PCR
P31	CATATACAATAGAAATATGAGTTTT	AACATATACGAGAAAACTTTT	Tiling PCR
P32	CATCATTATCATCTTATGGGTCATC	TAAAAAGAATTTTTTAAAAAC	Tiling PCR
P33	TGATATGGTATTACTTACAAACAAA	CCTCTATTTTCTATCATGTTTAC	Tiling PCR
P34	AAAACTGGGATACAAAAAGAAAA	ATTTTGGTTTTGATCCATACCA	Tiling PCR
P35	GGTAAATAGGTTTTGTTCTTATAAT	TCCCTAACAATAGCAAATAGTG	Tiling PCR
P36	TGGAAGCTCTGAATCTCTGATAGA	ATGTGATGACATGGAAGTAAA	Tiling PCR
P37	AAGTCTTTCAGTTAATTTCAGAAA	TAAACGCAGCCCCAATCTTAA	Tiling PCR
P38	TTGTGGCTCATCAATATATGTGTGT	GAAAATGACATTTTCCCTCAA	Tiling PCR
P39	ACATTTTATATTGCATCAATTATTTC	GAAAATGACATTTTCCCTCAA	Tiling PCR
P40	CCTTAACTAGTTTGACTTTAAGTTA	GAAAAGAAAAGAAACCAAAAAC	Tiling PCR
P41	CAATCTGCCGAAATATATAATAAAT	GTAGCACATCTGAATTTCCACT	Tiling PCR
P42	CTTGAGAGAGAAAAAAAATATCA	ATGAAACATTGAGAGAACACC	Tiling PCR
P43	CTGCTTAAACATGAATATTAAGATT	ATCGATCAAGGATCTTGACCA	Tiling PCR



Supplementary Figure S1. Related to Figure 1. Identification of COLDWRAP. (A) Schematic representation of RNA immunoprecipitation (RIP) followed by tiled quantitative RT-PCR across FLC region. (B) Relative levels of RNA retrieved by RIP using anti-CLF (upper panel) and IgG (lower panel) followed by quantitative RT-PCR. AG: AGAMOUS, NV, non-vernalized. 20V, 20 days of vernalization. 40V, 40 days of vernalization. Data (mean ± SD of quantitative PCR; n=2). (C) The sequence of COLDWRAP-containing region. The transcription start site of COLDWRAP is indicated as a green arrow. The transcription start site of FLC mRNA is indicated as a red arrow. Locations of primers used are indicated as underlined black arrows. (D) Strand-specific amplification of COLDWRAP using 5'RACE to determine the direction and the 5' end of COLDWRAP. Abridged Upstream Anchor primer (AUAP) with a COLDWRAP-specific P5 reverse primer was used to detect sense strand of COLDWRAP. P5 forward primer did not produce any detectable amplification (data not shown). Location of P5 reverse primer is indicated in (A&B). (C~D) COLDWRAP is transcribed in a sense direction relative to FLC mRNA. COLDWRAP is ~ 316 bases long and overlaps with 5' end of FLC mRNA. (E) 5' RACE followed by 3' end tiled RT-PCR to determine the 3' end of COLDWRAP. Total RNA purified from 40 days-vernalized samples was used for this analysis. Locations of primers used are indicated in (A). -RT; without reverse transcription. (F) Treatment of Terminator 5'-Phospho dependent exonuclease (TPE) alone does not degrade COLDWRAP, but the treatment with both TPE and Tobacco Acid Pyrophosphatase (TAP) does degrade the COLDWRAP. PP2A was used as a 5' capped mRNA control. (G) COLDWRAP is detected from ploy (A)-depleted fraction. Polyadenylated PP2A (At1g13320) was used as a control. (H) Chromatin immunoprecipitation using anti-CLF antibody. Relative levels of enrichments were shown between wild type and clf mutant (clf-29) at known CLF target loci, FLC, AGAMOUS (AG) and FUSCA3 (FUS3). Data (mean  $\pm$  SD of quantitative PCR; n = 3).



Supplementary Figure S2. Related to Figure 1. Characterization of COLDWRAP. (A) COLDWRAP is not an alternative FLC mRNA transcript. Relative positions of primer sets used in RT-PCR are indicated around the 5' part of FLC region (top). RT-PCR analyses using different combinatorial primer sets are shown (bottom). The FLC mRNA transcript was detected by primer set of forward primer U1 (5'UTR) and reverse primer E2 (the 2<sup>nd</sup> exon of FLC). Total RNA purified from 40 days-vernalized samples was used for this analysis. M, size marker. (B) Expression patterns of two different transcribed regions (P5 and P8) at 5' end of FLC. Schematic representation of relative positions of primer sets used in RT-PCR are indicated around 5' part of FLC region (top). Relative levels of RNA expressions were calculated compared to the control, PP2A (bottom). Mean  $\pm$  SD of quantitative RT-PCR data are shown (biological replicates n = 3). NV, non-vernalized. V, 40 days of vernalization treatment. (C) COLDWRAP is not a part of COLDAIR. Schematic representation of relative positions of primer sets used in RT-PCR are indicated at FLC region (top). RT-PCR analyses using different combinatorial primer sets are shown (bottom). (C, D) COLDWRAP is not an unspliced or alternately spliced version of FLC mRNA. COLDWRAP is not co-amplified with either FLC mRNA or unspliced FLC (D) RNA blot analysis using full length COLDWRAP anti-sense RNA probe. 316 bases of full-length antisense COLDWRAP overlap with 5'UTR of FLC, and, therefore, detect both COLDWRAP and FLC mRNA transcript. NV, non-vernalized. 40V, 40 days of vernalization treatment. (E) RNA blot analysis using FLC anti-sense probe (top) and non-overlapping COLDWRAP (157 bp of 5' COLDWRAP) anti-sense RNA probe (middle), and PP2A anti-sense probe (bottom). RNA samples were prepared from the wild type and *flc*-2FRI (in which the COLDWRAP region is deleted). Asterisks indicate non-specific bands. NV, non-vernalized. 10V, 10 days of vernalization, 20V, 20 days of vernalization, 40V, 40 days of vernalization, 40VT10, 40 days of vernalization followed by 10 days of normal growth temperature. Total RNA from vernalized *flc-2FRI* was used as a negative control. (D, E) PP2A was used as a loading control. M; RNA size marker. (F) Predicted secondary structure of COLDWRAP. Stem-and-loop structures subject to mutations shown in black circle. (G) RNA stability was not

affected by introduced mutations used for *in vitro* RNA binding assays (Fig. 1D, E). Equal amount of biotin-labeled RNAs (three microgram) were incubated in incubation buffer as described in M&M. Biotin-labeled RNAs were separated on RNA gel and visualized using BrightStar Biotin detection Kit (Ambion, TX, USA).



**Supplementary Figure S3. Related to Figure 2.** COLDWRAP knockdown compromises vernalization response. (A) Representative COLDWRAP knockdown lines (#3-2, #6-1) flower later compared to the wild type (WT) after vernalization. (B) Flowering times of multiple COLDWRAP knockdown lines at the second generation (T2) compared to the wild type (WT; *FRI*-Col) after 40 days of vernalization. More than 9 plants for each line were used to count the number of rosette leaves at the timing of flowering. (C) Expressions of COLDWRAP in two representative COLDWRAP knockdown lines (#3-2, #6-1) and in the wild type (WT) during the course of vernalization. (D) Expressions of COLDAIR transcripts in two representative COLDWRAP knockdown lines (#3-2, #6-1) and in the

wild type (WT) during the course of vernalization. (E) Expressions of COOLAIR transcripts in two representative COLDWRAP knockdown lines (#3-2, #6-1) and in the wild type (WT) during the course of vernalization. (F) Expressions of *FLC* in two representative COLDWRAP knockdown lines (#3-2, #6-1) and in the wild type (WT) during the course of vernalization. (C-F) Relative levels were calculated compared to the control, *PP2A*. Mean  $\pm$  SD of quantitative RT-PCR data are shown (biological replicates *n* =3). NV, non-vernalized. 20V, 20 days of vernalization treatment. 40V, 40 days of vernalization treatment. 40VT10, 40 days of vernalization treatment followed by 10 days of normal growth temperature. (G) Changes in occupancy of CLF at *FLC* chromatin during the course of vernalization. (H) Changes in enrichment of H3K27me3 at *FLC* chromatin during the course of vernalization. (G, H) Data (mean  $\pm$  SD of quantitative PCR; biological replicates *n* = 3). (I) Schematic representation of the *FLC* genomic region. Relative positions of primer sets used for ChIP assays are shown (P1 ~ P4).



Supplementary Figure S4. Related to Figures  $2 \sim 4$ . (A) Diagrams to depict the extent of transgenes carrying the wild-type FLC and the mutant COLDWRAP. Nucleotides forming stem part of stem-loop structure are in green capital letters. Mutated nucleotides disrupting stem structure are in red lower case letters. (B) Flowering times of 10 randomly selected transgenic lines carrying the "mutant COLDWRAP in *flc-2* mutant background at the second generation (T2) compared to the wild type (WT; FRI-Col) after 40 days of vernalization. More than 9 plants for each line were used to count the number of rosette leaves at the timing of flowering. (C) Flowering behavior of the representative transgenic lines carrying the mutant COLDWRAP in *flc-2* mutant background. (D) FT mRNA expression in wild type (FRI-Col), a representative transgenic line carrying the wild-type FLC in flc-2 mutant background (WT FLC gDNA +flc-2FRI #3-4), and a representative transgenic lines carrying the mutant COLDWRAP in flc-2 mutant background (mut FLCgDNA + flc-2FRI #1-6) during the course of vernalization. Expression of FLOWERING LOCUS T (FT), a downstream target of FLC, remains at low levels even after vernalization, consistent with late flowering phenotype of the mutant COLDWRAP lines compared to wild type. (E) Expressions of five FLC-related genes in wild type (FRI Col) and a representative transgenic line carrying the mutant COLDWRAP in flc-2 mutant background (#1-6) during the course of vernalization. The transgene carrying the mutant COLDWRAP expresses COLDWRAP at comparable levels during the course of vernalization compared to the wild type. Data (fold change; mean  $\pm$  SD of quantitative RT-PCR; biological replicates n = 3) is relative to the level of *PP2A* mRNA. Expressions of five *FLC*related genes are not affected in the transgenic lines carrying the mutant COLDWRAP compared to the wild-type plants, and there is no COLDWRAP-like sequences found in five FLC-related gene loci. Therefore, COLDWRAP specifically affects the regulation of FLC. (F) The transgene carrying the mutant COLDWRAP expresses COLDWRAP at comparable levels during the course of vernalization compared to the wild type. Data (fold change; mean  $\pm$  SD of quantitative RT-PCR; biological replicates n = 3) is relative to the level of PP2A mRNA. (D-F) Data (fold change; mean  $\pm$  SD of quantitative RT-PCR; biological replicates n = 3) is relative to the level of *PP2A* mRNA. NV, non-vernalized. 20V, 20 days of vernalization treatment. 40V, 40 days of vernalization treatment. 40VT10, 40 days of vernalization treatment followed by 10 days of normal growth temperature. 40VT20, 40 days of vernalization treatment followed by 20 days of normal growth temperature. (G) Flowering times of the wild type (FRI Col) and overexpression of COLDWRAP (FRI Col + 35S::COLDWRAP) without vernalization. Distribution of flowering times in the wild type (upper panel) and the primary transgenic lines (lower panel). (H) average flowering times of the wild type and the primary transgenic lines. (I) Genomic structure showing the deleted region in *flc-2FRI* (Michaels and Amasino, 1999). (J) The level of FLC expression of 12 randomly selected T2-pools of transgenic lines carrying the mutant COLDWRAP (mut FLC) in *flc-2* mutant background and the wild-type COLDWRAP (WT FLC) at the second generation (T2) compared to the wild type (WT; FRI-Col). Due to the FLC transgene variability, transgenic lines were grouped together based on their flowering time before vernalization.



**Supplementary Figure S5. Related to Figures 5 and 6.** Chromatin conformation capture (3C) assay at *FLC* by vernalization. (A) Relative fold changes of interaction frequency in 3C assay between different regions of *FLC* by vernalization were indicated. Relative interaction between F4 and R17 are set as 1. Data (mean  $\pm$  SD of quantitative 3C; biological replicates n = 2). Schematic representations of the *FLC* genomic region were given at upper panel. (B) Relative fold changes of interaction frequency in 3C assay between WT and COLDWRAP RNAi line (#3-2) of *FLC* during the course of vernalization. NV, non-vernalized, 10V, 10 days vernalized, 20V, 20 days vernalized, 30V, 30 days vernalized, 40V, 40 days vernalized, 40VT10, 40 days vernalized and followed by 10 days of normal growth temperature. Relative interaction between F4 and R17 of WT sample is set as 1. Data (mean  $\pm$  SD of quantitative 3C; biological replicates n = 2). (C) Schematic representation of the *PP2A* regions used as a control (see materials and methods for the detail).



**Supplementary Figure S6. Related to Figure 6.** COLDAIR promoter deletion lines. (A) Schematic representation of the transgene in which 76 bp of the putative COLDAIR intrinsic promoter is deleted. (B) Flowering times of *flc*-2*FRI* (left) and the primary transgenic lines carrying the COLDAIR promoter deletion in *flc*-2 mutant background after vernalization (right; n = 94). X-axis; range of rosette leaf numbers. (C) Flowering times of a representative transgenic lines carrying the COLDAIR promoter deletion in *flc*-2 mutant background without (NV) and with (40V) vernalization. (D) COLDAIR is not expressed in a representative transgenic line (#4-4) carrying the COLDAIR promoter deletion in *flc*-2 mutant background. Data (fold change; mean  $\pm$  SD of quantitative RT-PCR; biological replicates n = 3) is relative to the level of *PP2A* mRNA (E) FLC mRNA expression patterns in a representative transgenic line (#4-4) carrying the COLDAIR promoter deletion in *flc*-2 mutant background. *FLC* is de-repressed by vernalization in a representative transgenic line (#4-4) carrying the COLDAIR promoter deletion in *flc*-2 mutant background. Data (fold change; mean  $\pm$  SD of quantitative RT-PCR; biological replicates n = 3) is relative to the level of *PP2A* mRNA (E) FLC mRNA expression patterns in a representative transgenic line (#4-4) carrying the COLDAIR promoter deletion in *flc*-2 mutant background. *FLC* is de-repressed by vernalization in a representative transgenic line (#4-4) carrying the COLDAIR promoter deletion in *flc*-2 mutant background. Data (fold change; mean  $\pm$  SD of quantitative RT-PCR; biological replicates n = 3) is relative to the level of PP2A mRNA. (F) Restoration of the vernalization response by 35S::COLDAIR in a transgenic line (#4-4) carrying the COLDAIR promoter deletion. Flowering times of the primary 35S::COLDAIR transgenic lines (n = 12; blue bars) compared to the prenatal (#4-4; n = 8; black bar) after vernalization. *X*-axis; range of rosette leaf numbers