Supplementary Information

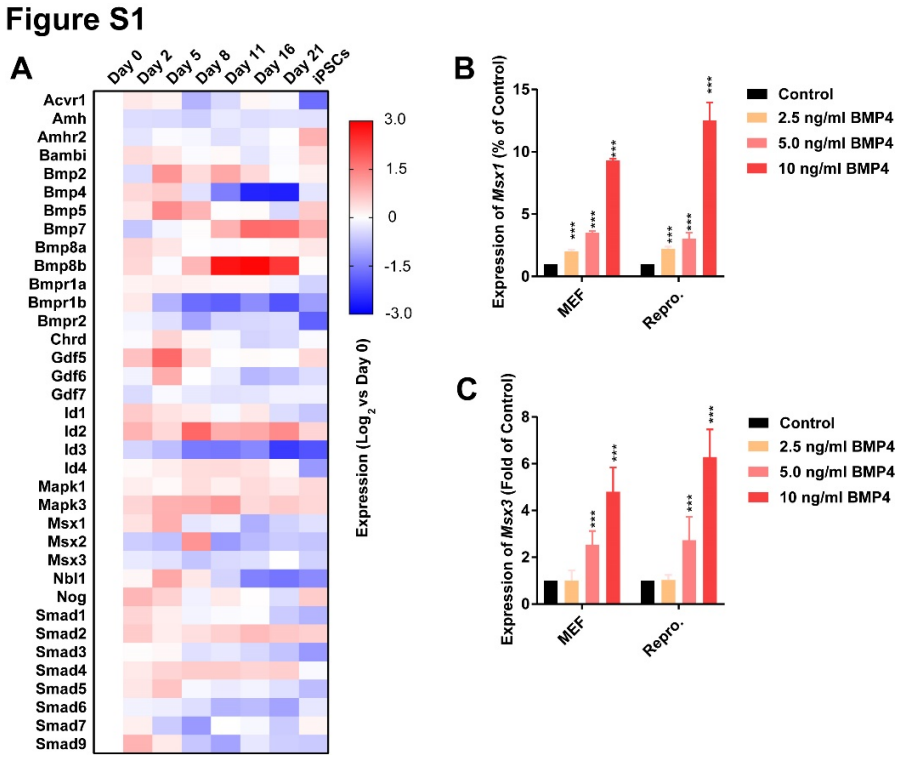
Supplementary Figure 1

Expression of factors in BMP pathway during reprogramming

(A) The expression of factors in BMP pathway (kegg: 04350) during reprogramming were summarized basing on previous reported microarray dataset (GSE21757).

(B-C) The abilities of BMP4 to up-regulate *Msx1/3* were determined by qPCR on Day 4 in both in MFEs and during reprogramming.

All experiments were repeated for at least five times. One-way ANOVA with Dunnett's post-hoc test was used.



Supplementary Figure 2

GFP$^+$ colonies generated with *Msx2* were iPSCs

GFP$^+$ colonies generated with *Msx2* were picked and cultured in mES medium.

(A) Exogenous expression of four Yamanaka factors were determined with qPCR.

(B) Endogenous expression of *Klf4*, *Sox2*, *Oct4*, and *Nanog* were determined with qPCR.

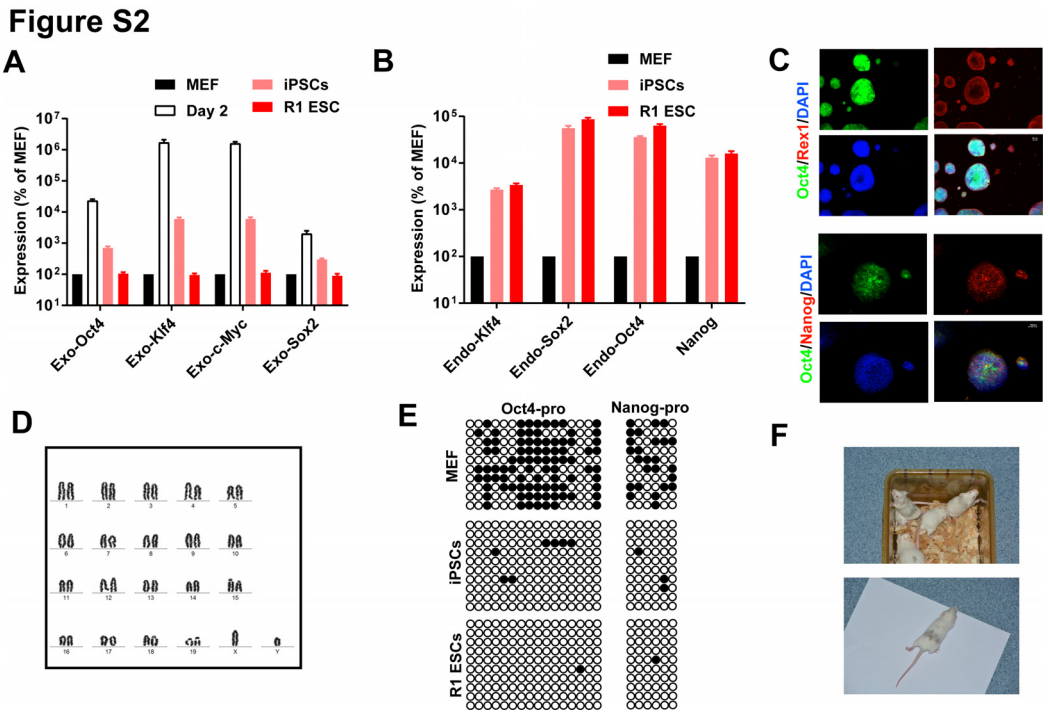
(C) The protein levels of SSEA1, Oct4, and Nanog were determined with immune-fluorescence.

(D) Karyotypes of GFP$^+$ colonies were determined

(E) DNA methylation on the promoters of *Oct4* and *Nanog* were determined

(F) GFP$^+$ colonies were able to contribute to chimera.

All experiments except chimera were repeated for at least five times. One-way ANOVA with Dunnett's post-hoc test was used.

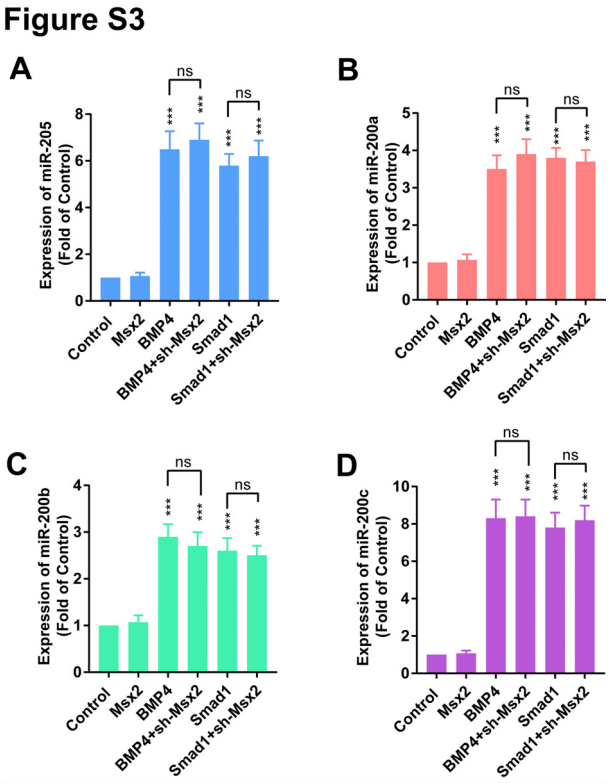


Supplementary Figure 3

***Msx2* did not regulate miR-205 and miR-200 family**

The abilities of BMP4, *Smad1* and *Msx2* to affect the expression of miR-205, miR-200a/b/c were determined on four days after virus delivery.

All experiments were repeated for at least five times. One-way ANOVA with Dunnett's post-hoc test was used.



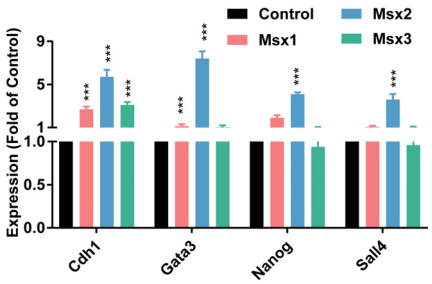
Supplementary Figure 4

Msx1 and Msx3 have less abilities to up-regulate the four targets

Msx1, *Msx2* or *Msx3* was over-expressed during reprogramming. The expression of *Cdh1, Gata3, Nanog,* and *Sall4* were determined on Day 4.

All experiments were repeated for at least five times. One-way ANOVA with Dunnett's post-hoc test was used.

Figure S4

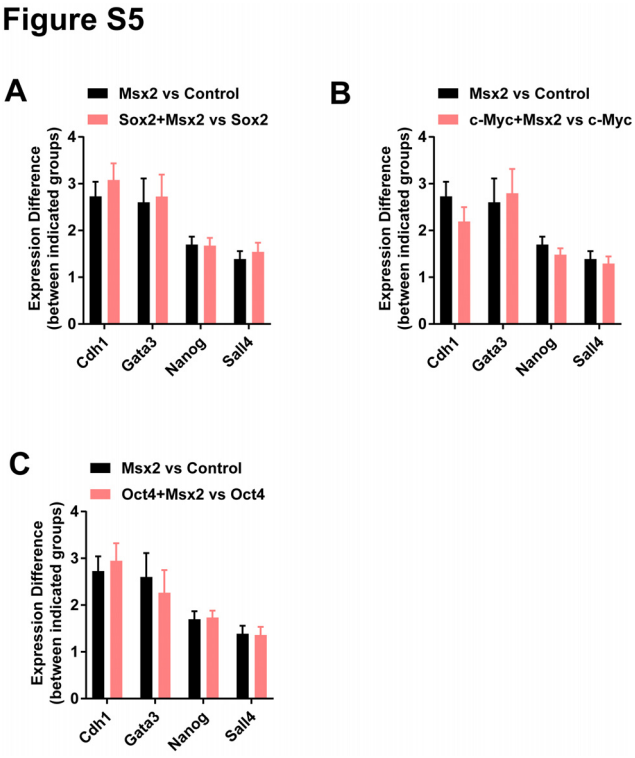


Supplementary Figure 5

Oct4, c-Myc, and Sox2 did not* potentiate the functions of *Msx2

Oct4, c-Myc, and *Sox2* were over-expressed alone or together with *Msx2* in MEFs. The expression of *Cdh1, Gata3, Nanog,* and *Sall4* were determined on Day 4. The abilities of *Msx2* to up-regulate these genes were calculated by performing comparisons indicated in (D).

All experiments were repeated for at least five times. One-way ANOVA with Dunnett's post-hoc test was used.



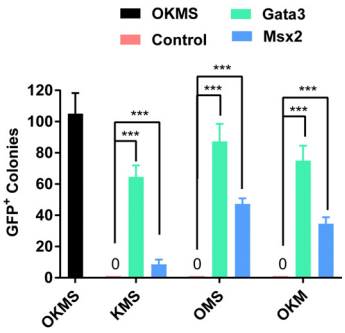
Supplementary Figure 6

***Msx2* can replace Oct4, Klf4, or Sox2 to induce reprogramming**

Msx2 or Gata3 were over-expressed with Klf4, c-Myc, and *Sox2* (KMS), *Oct4, c-Myc*, and *Sox2* (OMS), or *Oct4, Klf4*, and *c-Myc* (OKM). GFP^+ colonies were counted on Day 15.

All experiments were repeated for at least five times. One-way ANOVA with Dunnett's post-hoc test was used.

Figure S6



Supplementary Table S1

The current RNA-seq results

RNA-seq were performed on Day 4 and 8 during reprogramming with the expression of *Msx2* modulated.

Supplementary Table S2

The material used in the current studies

As title