

## **Description of Additional Supplementary Files**

**Supplementary Data 1.** Patient clinical characteristics and sample information.

**Supplementary Data 2.** Cell type-characteristic genes in the UMAP representation of APL blasts.

**Supplementary Data 3.** Branch-characteristic genes in the UMAP representation of APL blasts.

**Supplementary Data 4.** Genome-wide binding sites of PML/RAR $\alpha$  identified by CUT&Tag-seq.

**Supplementary Data 5.** PML/RAR $\alpha$ -regulated branch-specific marker genes in different branches.

**Supplementary Data 6.** Differentially expressed genes (DEGs) between APL stem-like cells and normal HSPCs, along with the information on PML/RAR $\alpha$  targets.

**Supplementary Data 7.** List of pathway crosstalk genes, along with their manually curated relatedness to stemness and APL biology.

**Supplementary Data 8.** Clinical and molecular features of 323 APL patients.

**Supplementary Data 9.** Proportions of the 6 cell branches in 16 APL patients.

**Supplementary Data 10.** Mean expression of genes in stem-like, Prog-like, S100<sup>hi</sup>GMP-like, and GMP-like cell populations on Day 0 (D0) and Day 2 (D2) after ATRA therapy, respectively.

**Supplementary Data 11.** Log<sub>2</sub>FC of gene expression in 9 APL patients by comparing bulk RNA-seq data before and after ATRA treatment for two days (Day 2 vs. Day 0), respectively.