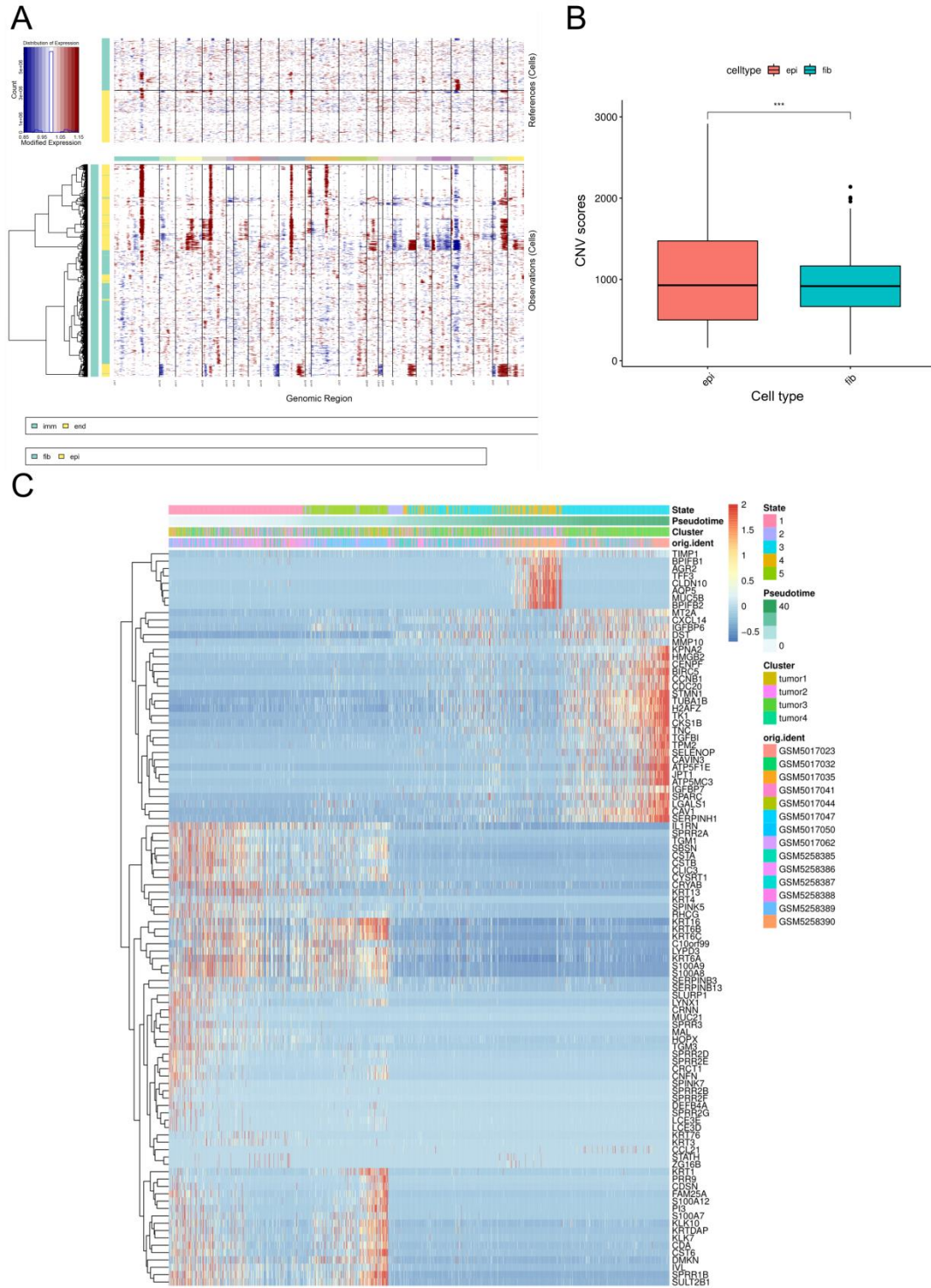**Supplementary Figure S1. Quality control and visualization of marker gene expression** The distribution of feature_RNA, count_RNA and mitochondrial RNA proportions were revealed by violin plots before (A) and after (B) quality control. (C) Bubble plot shows selected cell type-specific markers among 33 clusters. The size of the dots represents the fraction of cells expressing a particular marker, and the intensity of the color indicates the level of mean expression. (D) Bubble plot shows

selected cell type–specific markers among major cell types. (E) The levels of genes uniquely expressed in different cell types were projected onto the UMAP atlas.

**Supplementary Figure S2. CNV analysis of epithelial cells and CAFs** (A) CNV distributions of epithelial cells and CAFs were identified in the genomic region. (B) CNV scores of epithelial cells and CAFs. (C) Heatmap of differentially expressed genes in tumor progression ordered by state, pseudotime, cell type and patient. epi: epithelial cell, imm: immune cell, fib: CAF, end: endothelial cell.