Supplementary Table S7. Benchmark results of MCC2 for SignalP 6.0, Fine-tuning ESM-2 model family, and PEFT-SP using different PEFT methods with ESM-2 model family. The SP type indicated with the symbol † represents SP types with limited training samples. The bold value indicates the highest value for each SP type among all methods.

Method	Baseline	Fine-tuning			Prompt Tuning			Adapter Tuning			LoRA Tuning		
Backbone	SignalP 6.0	ESM2-150M	ESM2-650M	ESM2-3B	ESM2-150M	ESM2-650M	ESM2-3B	ESM2-150M	ESM2-650M	ESM2-3B	ESM2-150M	ESM2-650M	ESM2-3B
Archaea Sec/SPI	0.793	0.749	0.803	0.771	0.689	0.784	0.777	0.820	0.802	**0.825**	0.785	0.749	0.783
Archaea Sec/SPII	0.825	0.804	0.880	0.864	0.541	0.723	0.509	0.882	0.798	0.783	**0.912**	0.798	0.730
Archaea Sec/SPIII †	0.426	0.446	0.464	0.724	0.318	0.568	0.500	0.672	0.639	0.351	0.618	0.471	**0.798**
Archaea Tat/SPI	0.563	0.756	0.614	0.564	0.389	0.499	0.653	0.583	0.755	0.538	0.574	**0.863**	0.579
Archaea Tat/SPII †	0.718	0.805	0.872	0.792	0.295	0.455	0.182	0.596	**0.920**	0.660	0.721	0.887	0.850
Eukarya Sec/SPI	0.958	0.952	0.960	0.948	0.921	0.935	0.954	0.951	0.949	0.954	0.951	0.939	**0.960**
Negative Sec/SPI	0.804	0.790	0.820	0.813	0.695	0.737	0.723	0.823	0.829	0.820	**0.838**	0.802	0.809
Negative Sec/SPII	0.929	0.920	0.948	0.946	0.854	0.898	0.886	0.939	0.932	0.950	**0.953**	0.939	0.945
Negative Sec/SPIII †	0.902	0.971	0.963	**0.982**	0.927	0.978	0.970	0.883	0.964	0.899	0.888	0.870	0.919
Negative Tat/SPI	0.962	0.959	0.943	0.902	0.747	0.934	0.853	0.955	0.964	0.899	**0.967**	0.943	0.961
Negative Tat/SPII †	0.486	0.429	0.405	0.358	0.084	0.449	0.325	0.309	0.481	0.405	0.293	0.458	**0.520**
Positive Sec/SPI	0.770	0.812	**0.868**	0.810	0.662	0.725	0.746	0.845	0.814	0.814	0.827	0.831	0.848
Positive Sec/SPII	0.882	0.910	0.923	0.908	0.767	0.835	0.833	0.928	0.892	0.911	0.933	0.911	**0.939**
Positive Sec/SPIII †	0.902	**1.000**	0.951	**1.000**	**1.000**	**1.000**	0.951	0.873	0.969	0.969	0.938	0.911	**1.000**
Positive Tat/SPI	0.799	0.842	0.819	0.746	0.575	0.644	0.590	0.799	0.721	0.752	0.808	0.732	**0.850**
Positive Tat/SPII †	**0.786**	0.606	0.636	0.603	0.240	0.233	0.148	0.587	0.540	0.669	0.620	0.427	0.783
mean	0.781	0.797	0.804	0.796	0.606	0.712	0.663	0.778	0.811	0.762	0.789	0.783	**0.830**