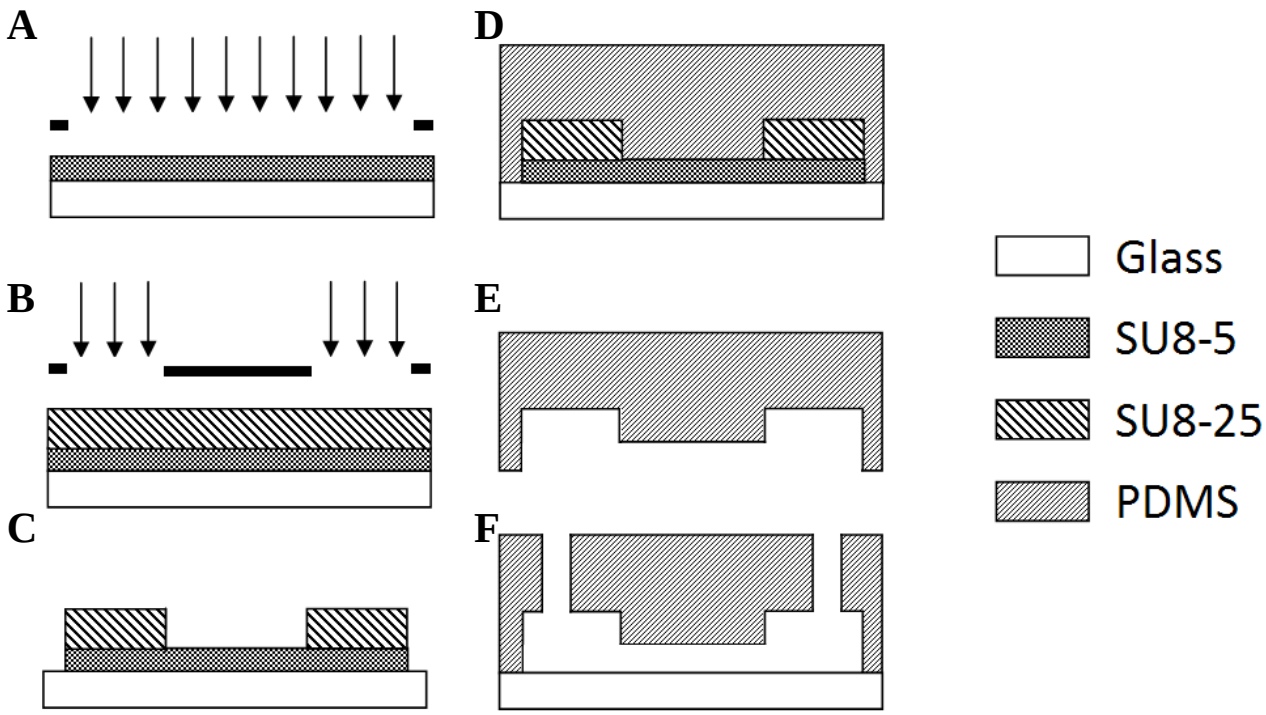
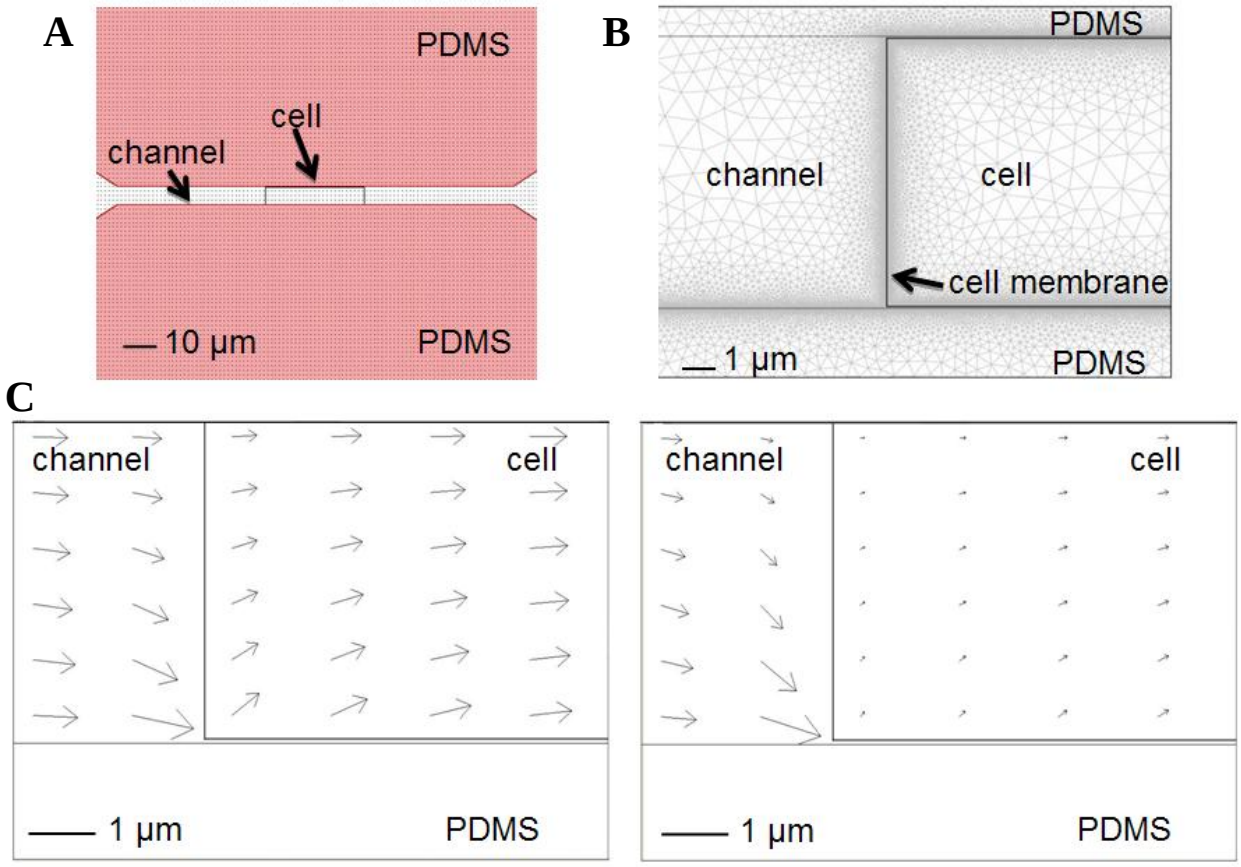
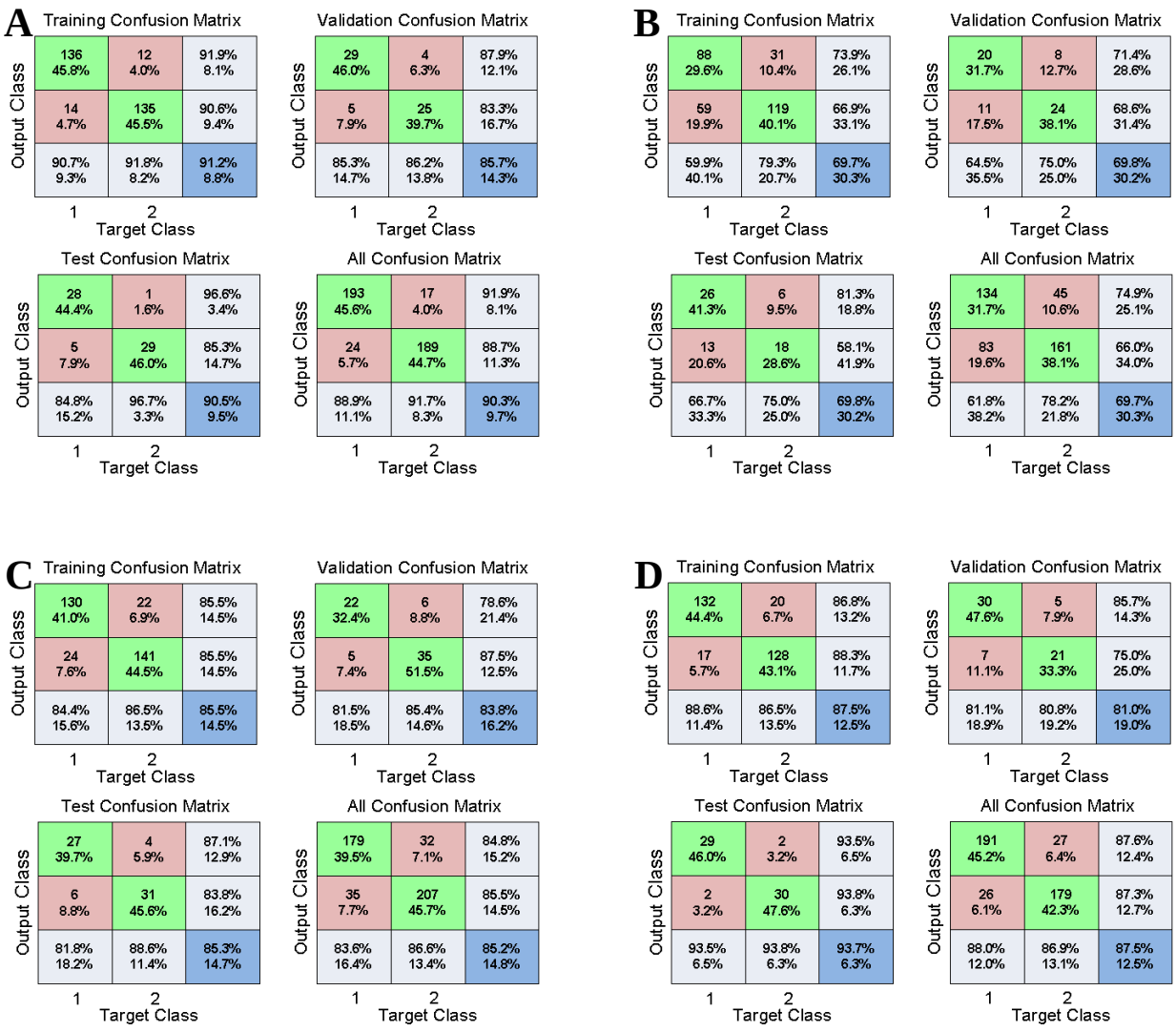
Supplementary Materials



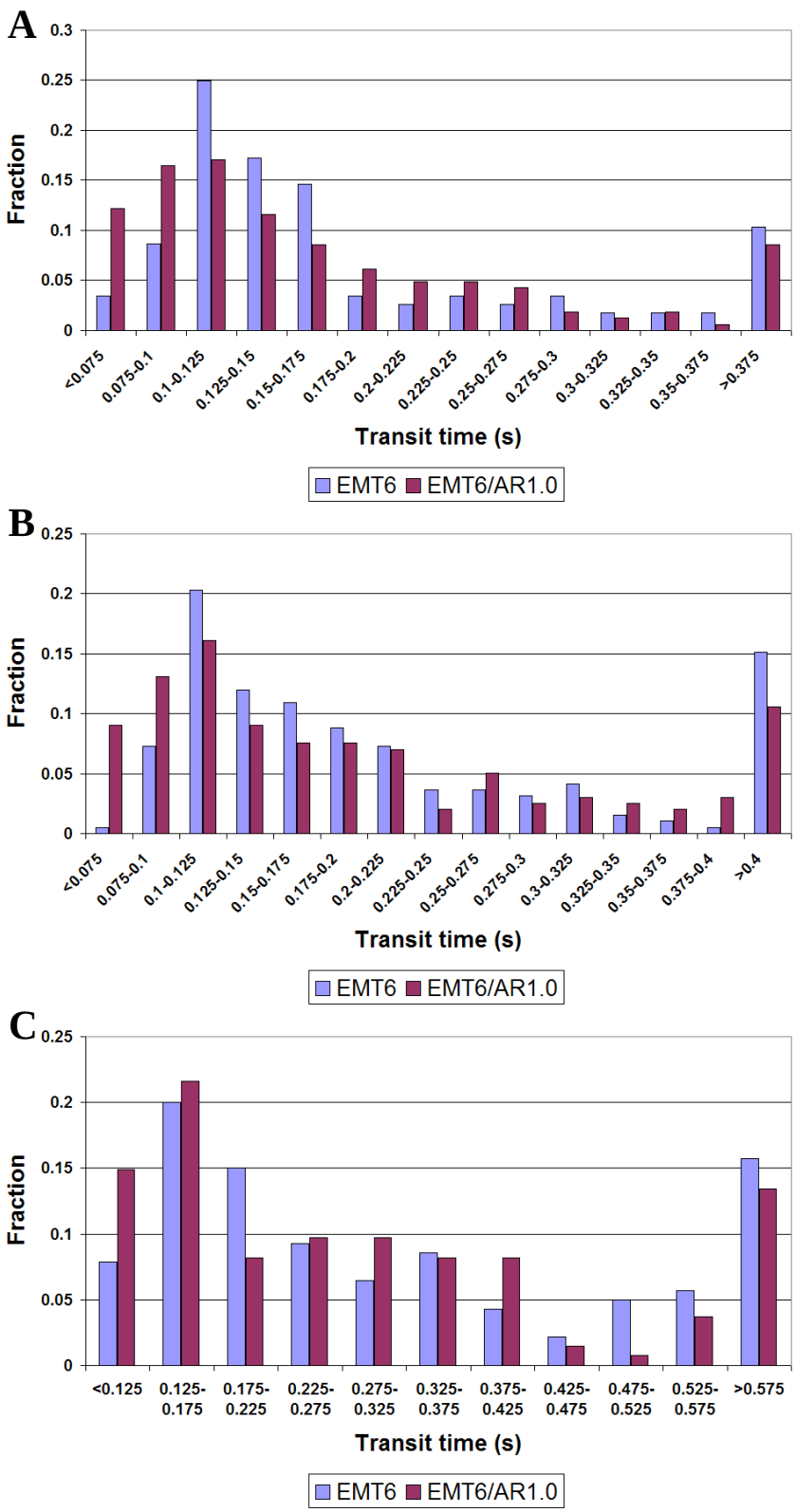
Supplementary Figure S.1: Fabrication of the two-layer PDMS device. Two layers of SU-8 were used to form mold masters.



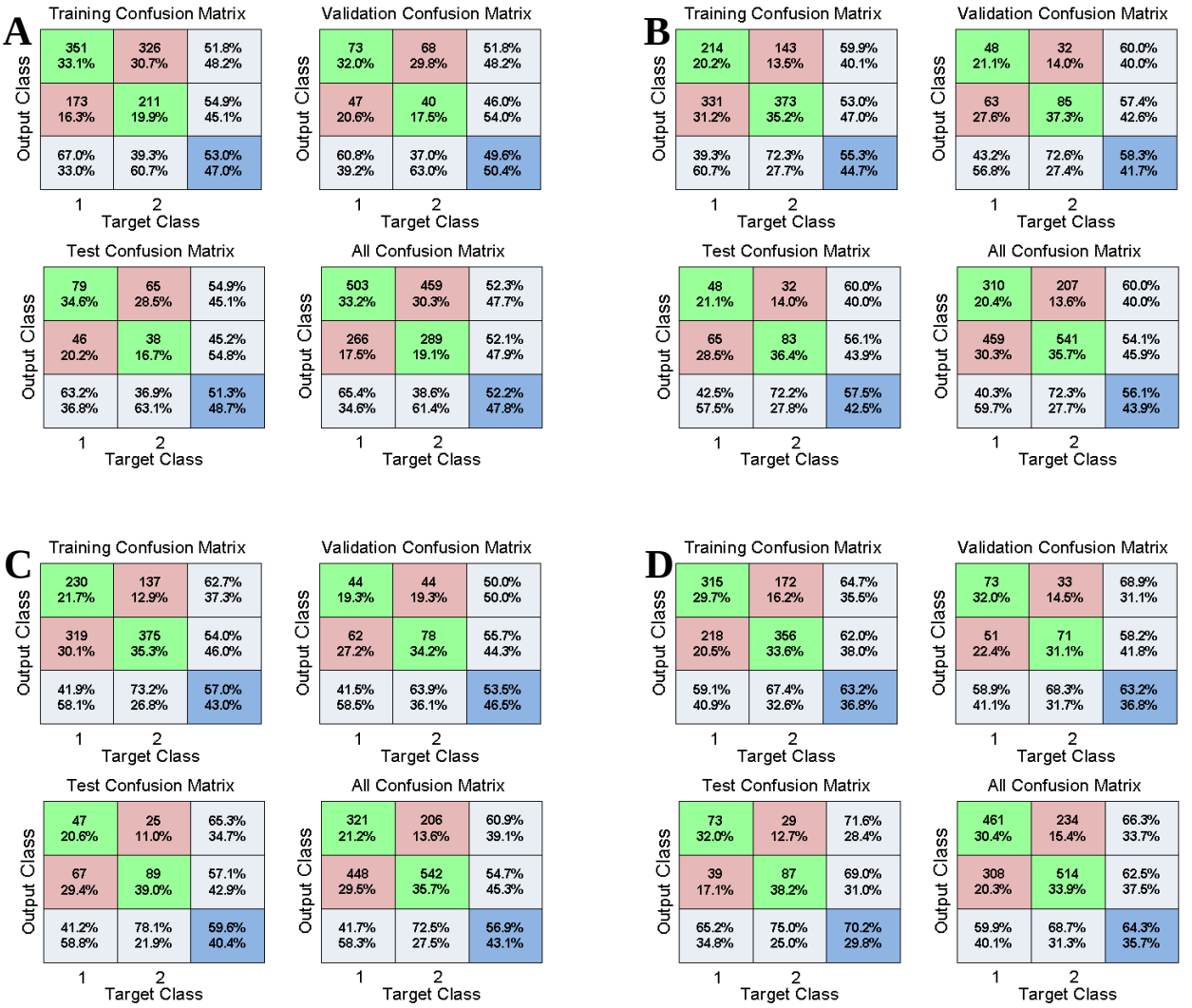
Supplementary Figure S.2: (A) Schematic of the 2-D numerical model used in simulation. Geometric parameters are listed in Supplementary Table S.1 (B) A section of meshing with 380,000 elements. (C) Simulation results of current density as a frequency of 100 kHz (left) and 10 kHz (right). Arrow: total current density. Due to the existence of cell membrane, more electric field lines pass around the cell at 10 kHz compared to 100 kHz. At 100 kHz, cellular membrane impedance is lower and therefore, more electric field lines penetrate the cell membrane. As the frequency increases from 10 kHz to 100 kHz, cellular electrical properties rather than cell-channel sealing properties are reflected by impedance measurement data.



Supplementary Figure S.3: Pattern recognition using neural network for classifying osteoblasts (n=206) and osteocytes (n=217). (A) Confusion matrix with the input of cell elongation length. Success rates: 91.2% (training group), 85.7% (validation group), and **90.5%** (test group). (B) Confusion matrix with the input of transit time. Success rates: 69.7% (training group), 69.8% (validation group), and **69.8%** (test group). (C) Confusion matrix with the input of impedance amplitude ratio. Success rates: 85.5% (training group), 83.8% (validation group), and **85.3%** (test group). (D) Confusion matrix with the input of transit time and impedance amplitude ratio. Success rates: 87.5% (training group), 81.0% (validation group) and **93.7%** (test group).



Supplementary Figure S.4: The distribution of transit time of EMT6 and EMT6/AR1.0 cells within grouped cell elongation lengths. (A) Cell elongation length of 40-45 µm (EMT6 (n=112) and EMT6/AR1.0 (n=144)). (B) Cell elongation length of 45-50 µm (EMT6 (n=192) and EMT6/AR1.0 (n=199)). (C) Cell elongation length of 50-55 µm (EMT6 (n=140) and EMT6/AR1.0 (n=134)).



Supplementary Figure S.5: Pattern recognition using neural network for classifying EMT6 (n=747) and EMT6/AR1.0 (n=770). (A) Confusion matrix with the input of cell elongation length. Success rates: 53.0% (training group), 49.6% (validation group), and **51.3%** (test group). (B) Confusion matrix with the input of transit time. Success rates: 55.3% (training group), 58.3% (validation group), and **57.5%** (test group). (C) Confusion matrix with the input of impedance amplitude ratio. Success rates: 57.0% (training group), 53.5% (validation group), and **59.6%** (test group). (D) Confusion matrix with the input of transit time and impedance amplitude ratio. Success rates of 63.2% (training group), 63.2% (validation group), and **70.2%** (test group).

Supplementary table S.1: parameters and values used in numerical simulation.

Parameter	Value
Constriction channel length	200 μm
Constriction channel width	8 μm
Cell elongation length	50 μm
Cell elongation width	7.9 μm
Cell membrane thickness	10 nm
Culture medium conductivity	1 S/m
Culture medium relative permittivity	80
PDMS conductivity	0 S/m
PDMS relative permittivity	5
Cell membrane conductivity	0 S/m
Cell membrane relative permittivity	20
Cell cytoplasm conductivity	0.4 S/m
Cell cytoplasm relative permittivity	80