



Shear Stress and Flow Rates for ExiGo™ Pump

With Cellix Biochips using 5 mL Plastic Syringe

Example Shear Stress and Flow Rates for ExiGo Pump with Cellix Biochips using 5 mL plastic syringe

Sample	Vena8 Endothelial+ Biochips		Vena8 Fluoro+ Biochips		Vena8GCS — LOW FLOW RATES		Vena8GCS — HIGH FLOW RATES		VenaT4 Biochips		
	Flow Rate per Channel ($\mu\text{L}/\text{min}$)	Shear Stress per Channel (dyne/cm^2)	Shear Rate per Channel (s^{-1})	Shear Stress per Channel (dyne/cm^2)	Shear Rate per Channel (s^{-1})	Shear Stress per Channel (dyne/cm^2)	Shear Rate per Channel (s^{-1})	Shear Stress per Channel (dyne/cm^2)	Shear Rate per Channel (s^{-1})	Shear Stress per Channel (dyne/cm^2)	Shear Rate per Channel (s^{-1})
Cell suspension	1.00	0.09	9	0.25	25	0.02	2	0.20	20	0.13	13
Cell suspension	5.00	0.43	43	1.25	125	0.12	12	0.98	98	0.63	63
Cell suspension	10.00	0.87	87	2.50	250	0.24	24	1.95	195	1.25	125
Cell suspension	20.00	1.74	174	5.00	500	0.49	49	3.91	391	2.50	250
Cell suspension	50.00	4.34	434	12.50	1,250	1.22	122	9.77	977	6.25	625
Cell suspension	100.00	8.68	868	25.00	2,500	2.44	244	19.53	1,953	12.50	1,250
Cell suspension	200.00	17.36	1,736	50.00	5,000	4.88	488	39.06	3,906	25.00	2,500
Whole blood	5.00	1.95	43	5.63	125	0.55	12	4.39	98	2.81	62
Whole blood	10.00	3.91	87	11.25	250	1.10	24	8.79	195	5.63	125
Whole blood	20.00	7.81	174	22.50	500	2.20	49	17.58	391	11.25	250
Whole blood	50.00	19.53	434	56.25	1,250	5.49	122	43.95	977	28.13	625
Whole blood	100.00	39.06	868	112.50	2,500	10.99	244	87.89	1,953	56.25	1,250
Whole blood	200.00	78.13	1,736	225.00	5,000	21.97	488	175.78	3,906	112.50	2,500

	Vena8 Endothelial+ Biochips	Vena8 Fluoro+ Biochips	Vena8GCS — LOW FLOW RATES	Vena8GCS — HIGH FLOW RATES	VenaT4 Biochips
Channel width, b (cm)	0.08	0.04	0.16	0.08	0.08
Channel height, h (cm)	0.012	0.01	0.016	0.008	0.01
Channel length, l (cm)	2.8	2.8	2.8	2.8	2.8
Microcapillary/channel volume (cm^3)	0.002688	0.00112	0.007168	0.00179	0.00224
Microcapillary/channel volume (μL)	2.688	1.12	7.168	1.792	2.24

Flow rate: $Q = \tau bh^2/6\mu$

Shear Stress: $\tau = 6Q\mu/ bh^2$

Viscosity of cell culture suspension, $\mu = 0.01$ dynes/cm²·s

Viscosity of whole blood, $\mu = 0.045$ dynes/cm²·s

Equivalent to: cm³/s = 0.001 L/s = 0.06 L/min = 60 mL/min = 60000 μ L/min

Sample	VenaDeltaY1 Biochips			VenaDeltaY2 Biochips	
	Flow Rate per Channel (L/min)	Shear Stress per Channel (dyne/cm ²)	Shear Rate per Channel (s ⁻¹)	Shear Stress per Channel (dyne/cm ²)	Shear Rate per Channel (s ⁻¹)
Cell suspension	1.00	0.09	9	0.17	17
Cell suspension	5.00	0.43	43	0.83	83
Cell suspension	10.00	0.87	87	1.67	167
Cell suspension	20.00	1.74	174	3.33	333
Cell suspension	50.00	4.34	434	8.33	833
Cell suspension	100.00	8.68	868	16.67	1,667
Cell suspension	200.00	17.36	1,736	33.33	3,333
Whole blood	5.00	1.95	43	3.75	83
Whole blood	10.00	3.91	87	7.50	167
Whole blood	20.00	7.81	174	15.00	333
Whole blood	50.00	19.53	434	37.50	833
Whole blood	100.00	39.06	868	75.00	1,667
Whole blood	200.00	78.13	1,736	150.00	3,333

	VenaDeltaY1 Biochips	VenaDeltaY2 Biochips
Channel width, b (cm)	0.08	0.06
Channel height, h (cm)	0.012	0.01
Channel length, l (cm)	2.8	2.8
Microcapillary/channel volume (cm ³)	0.002688	0.00168
Microcapillary/channel volume (μ L)	2.688	1.68