

Supplementary Information: Mimicking Red Blood Cell Lipid Membrane to Enhance the Hemocompatibility of Large-Pore Mesoporous Silica

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The following SEM figures represent a quantification of the interactions between large pore mesoporous silica nanoparticles coated with either dipalmitoylphosphatidyl choline (DPPC-LP-MSNs, Fig. 1) or a mixture containing dipalmitoylphosphatidylcholine, dipalmitoylphosphatidylethanolamine and cholesterol in a weight ratio of 4:1:5 (mRBC-LP-MSNs Fig. 2). Due to the restrictions of the SEM images, only the red blood cells (RBCs) that are clearly visible (not obscured by other cells or particles) and have an obvious association with LP-MSNs were counted. Stomatocytic (cup-shaped) may be under-represented in our count do to the lack of 3-dimensional imaging that is available to other studies which utilize confocal microscopy to make morphological determinations. The “health factor” (HF) calculated for these studies is determined using the following formula where discocytic (D) morphologies are marked

with green circles and stomatocytic and echinocytic (SE) morphologies are marked with red circles. The morphologies are identified using the work of Khairy, Foo, and Howard as guide.¹

$$\frac{D-ES}{Total\ Count} = HF \quad \text{eq. 1}$$

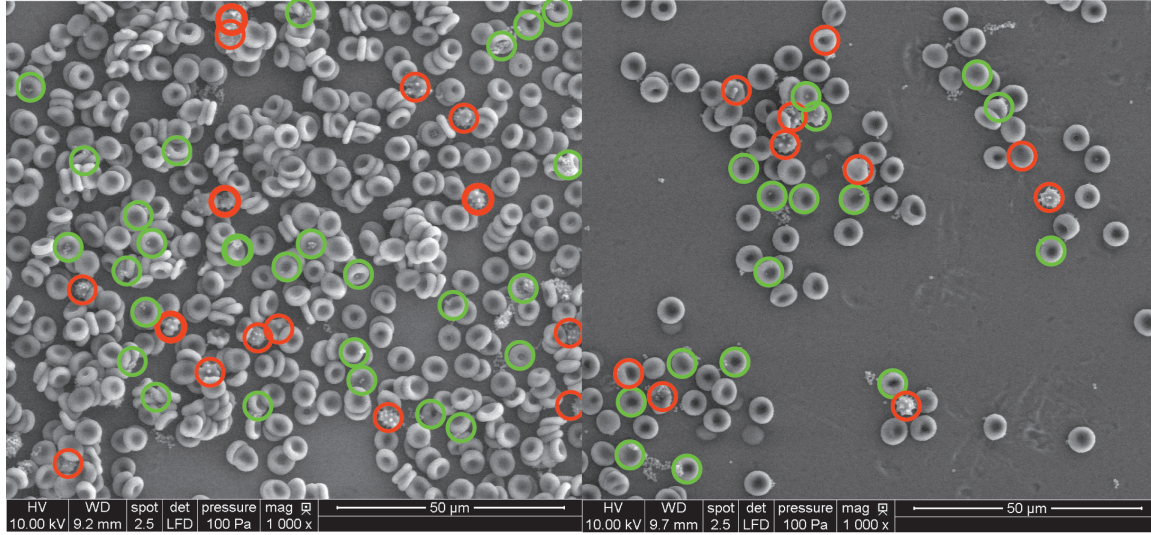


Figure 1. SEM images of RBCs exposed to DPPC-LP-MSNs at 50 µg mL⁻¹ (left panel) and 100 µg mL⁻¹ (right panel). The HF for the RBCs in these images is calculated to be 0.089 indicating that the counted interactions between DPPC-LP-MSNs and RBCs are divided equally between healthy cells (green circles) and cells with abnormal morphology (red circles).

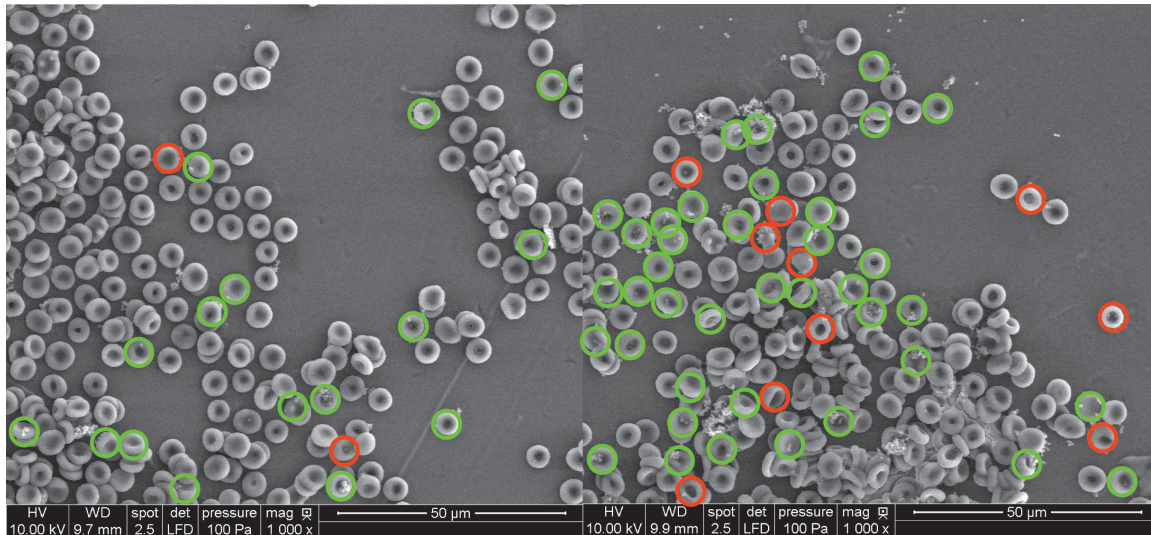


Figure 2. SEM images of RBCs exposed to mRBC-LP-MSN at $50 \mu\text{g mL}^{-1}$ (left panel) and $100 \mu\text{g mL}^{-1}$ (right panel). The HF for the RBCs in these images is calculated to be 0.64 indicating that the counted interactions between mRBC-LP-MSNs result predominately in cells with normal morphology (green circles) as opposed to abnormal morphologies (red circles).

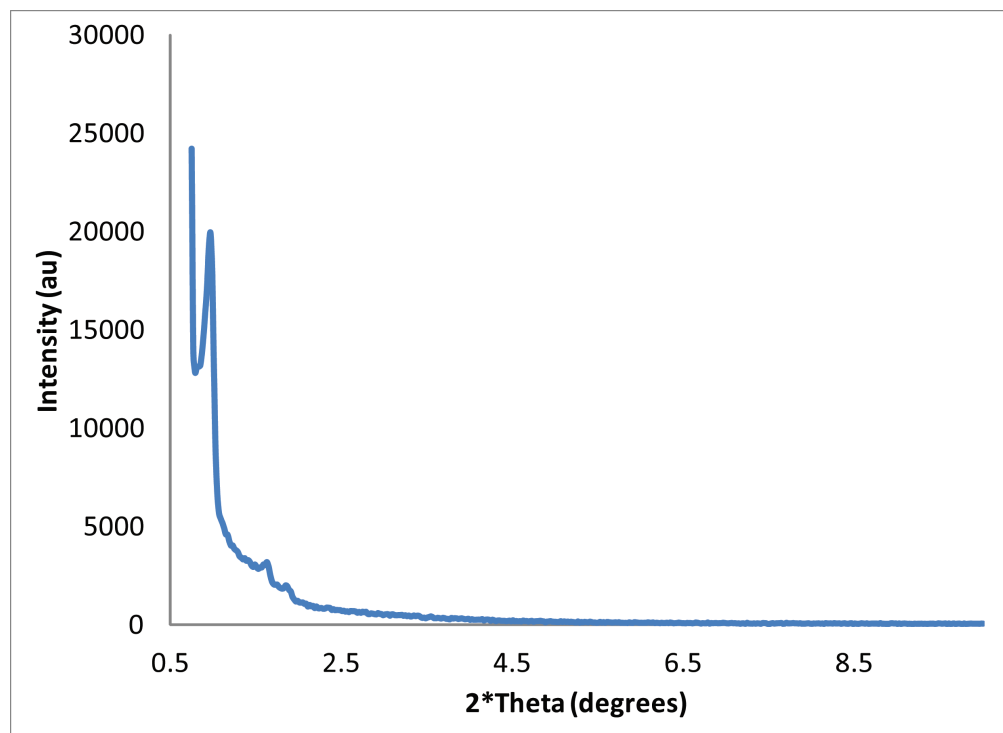


Figure 3. Powder X-ray diffraction pattern of *l*-MSN

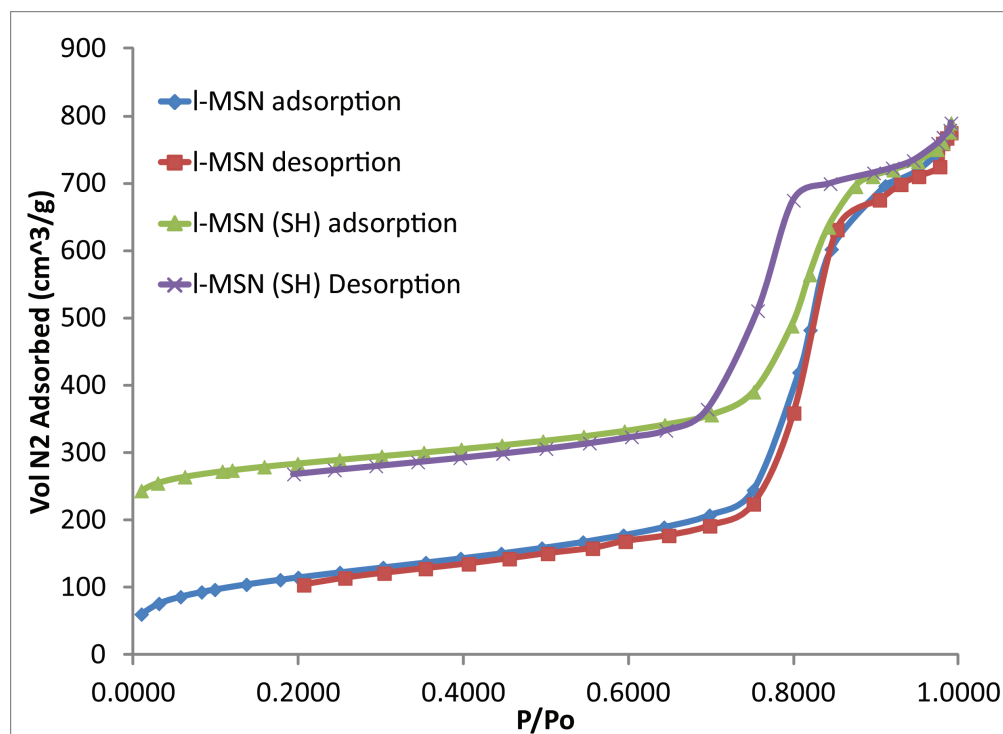
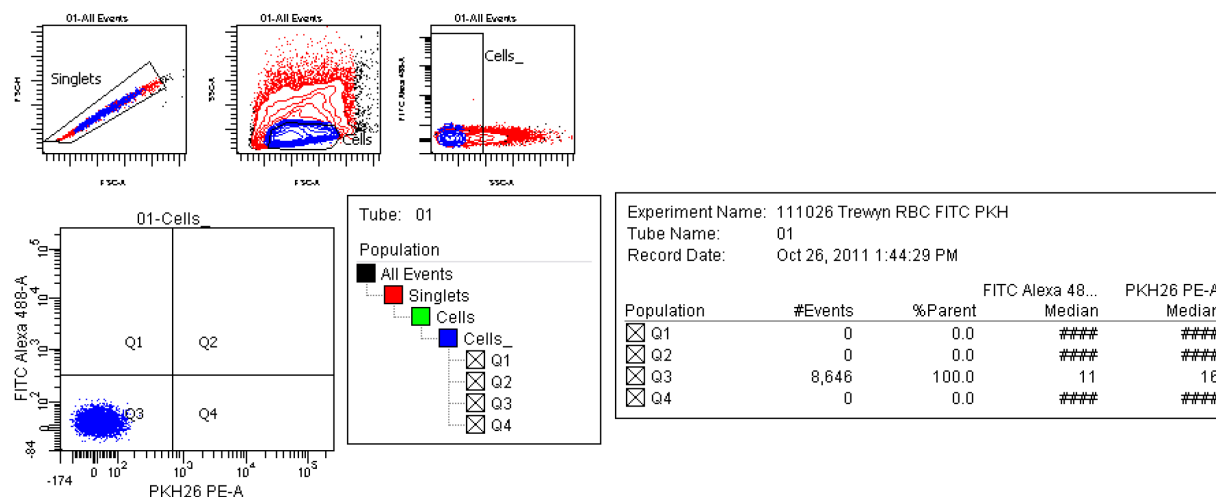
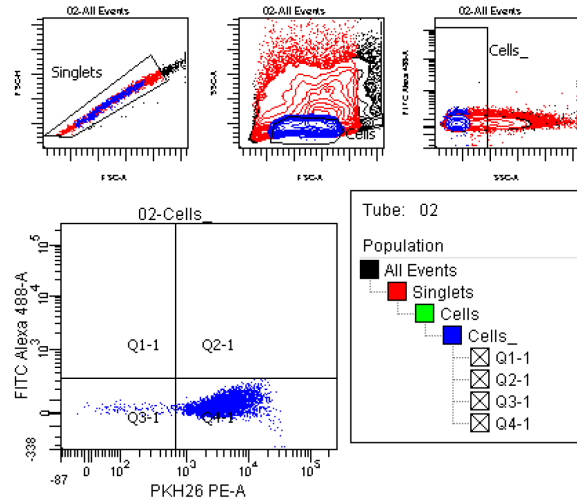


Figure 4. Nitrogen sorption isotherms of *l*-MSN (surfactant removed) and *l*-MSN that was post-synthetically grafted with 3-mercaptopropyltriethoxy silane (*l*-MSN (SH)).

110614 Trewyn RBC FITC-1-Lipid Bilayer

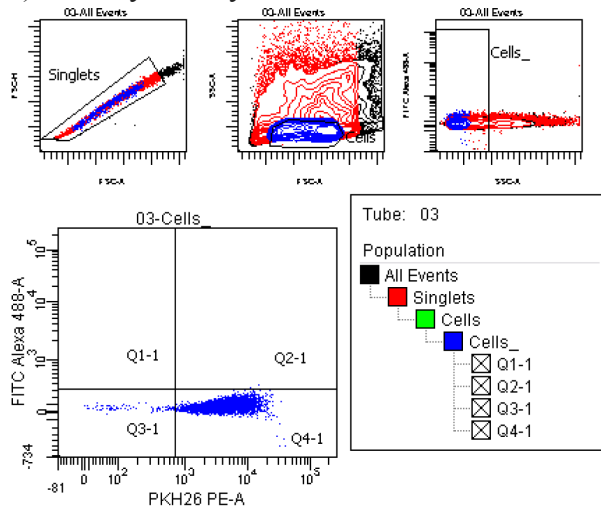


1) Flow cytometry data for human RBC without PKH26 dye or MSN.



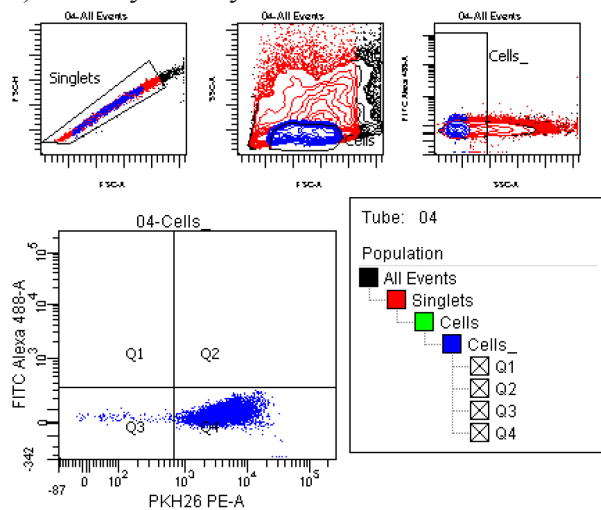
Experiment Name: 111026 Trewyn RBC FITC PKH				
Tube Name: 02				
Record Date: Oct 26, 2011 1:45:43 PM				
Population	#Events	%Parent	FITC Alexa 48... Median	PKH26 PE-A Median
<input checked="" type="checkbox"/> Q1-1	0	0.0	###	###
<input checked="" type="checkbox"/> Q2-1	0	0.0	###	###
<input checked="" type="checkbox"/> Q3-1	104	1.8	21	175
<input checked="" type="checkbox"/> Q4-1	5,664	98.2	49	4,063

2) Flow cytometry data for human RBC with PKH26 dye, but without MSN (run 1).



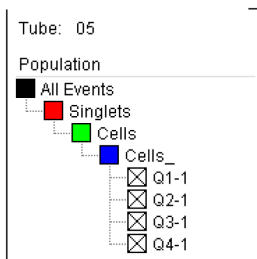
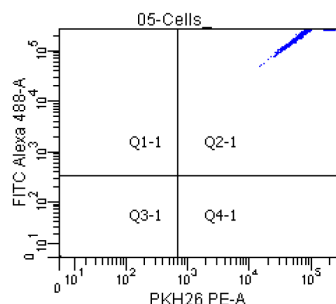
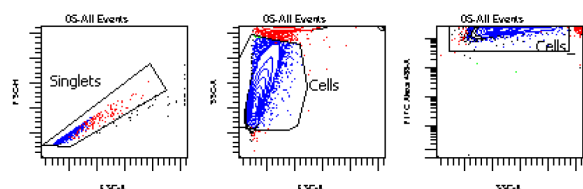
Experiment Name: 111026 Trewyn RBC FITC PKH				
Tube Name: 03				
Record Date: Oct 26, 2011 1:46:58 PM				
Population	#Events	%Parent	FITC Alexa 48... Median	PKH26 PE-A Median
<input checked="" type="checkbox"/> Q1-1	0	0.0	###	###
<input checked="" type="checkbox"/> Q2-1	1	0.0	351	15,473
<input checked="" type="checkbox"/> Q3-1	91	1.6	27	148
<input checked="" type="checkbox"/> Q4-1	5,745	98.4	50	4,009

3) Flow cytometry data for human RBC with PKH26 dye, but without MSN (run 2).



Experiment Name: 111026 Trewyn RBC FITC PKH				
Tube Name: 04				
Record Date: Oct 26, 2011 1:48:13 PM				
Population	#Events	%Parent	FITC Alexa 48... Median	PKH26 PE-A Median
<input checked="" type="checkbox"/> Q1	0	0.0	###	###
<input checked="" type="checkbox"/> Q2	0	0.0	###	###
<input checked="" type="checkbox"/> Q3	94	1.6	26	124
<input checked="" type="checkbox"/> Q4	5,794	98.4	49	4,041

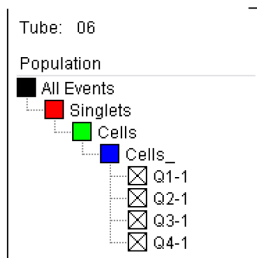
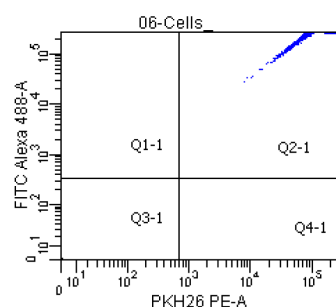
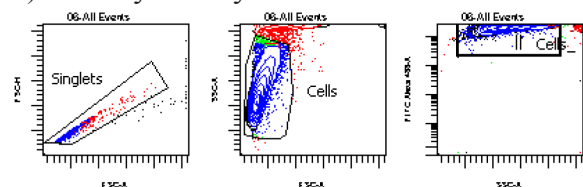
4) Flow cytometry data for human RBC with PKH26 dye, but without MSN (run 3).



Experiment Name: 111026 Trewyn RBC FITC PKH
Tube Name: 05
Record Date: Oct 26, 2011 1:49:40 PM

Population	#Events	%Parent	FITC Alexa 48... Median	PKH26 PE-A Median
<input checked="" type="checkbox"/> Q1-1	0	0.0	####	####
<input checked="" type="checkbox"/> Q2-1	10,895	100.0	251,576	95,236
<input checked="" type="checkbox"/> Q3-1	0	0.0	####	####
<input checked="" type="checkbox"/> Q4-1	0	0.0	####	####

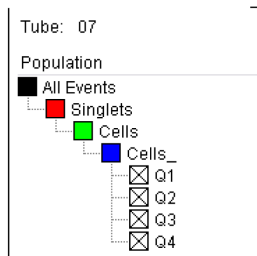
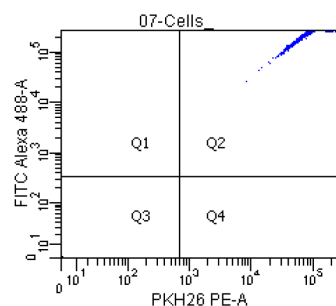
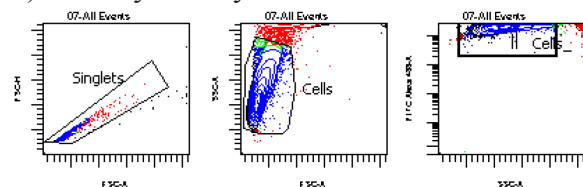
5) Flow cytometry data of mRBC-MSN without human RBC or PKH26 dye (run 1).



Experiment Name: 111026 Trewyn RBC FITC PKH
Tube Name: 06
Record Date: Oct 26, 2011 1:51:05 PM

Population	#Events	%Parent	FITC Alexa 48... Median	PKH26 PE-A Median
<input checked="" type="checkbox"/> Q1-1	0	0.0	####	####
<input checked="" type="checkbox"/> Q2-1	9,365	100.0	245,592	92,516
<input checked="" type="checkbox"/> Q3-1	0	0.0	####	####
<input checked="" type="checkbox"/> Q4-1	0	0.0	####	####

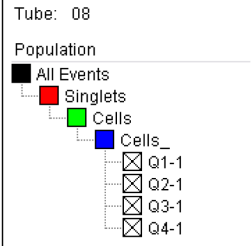
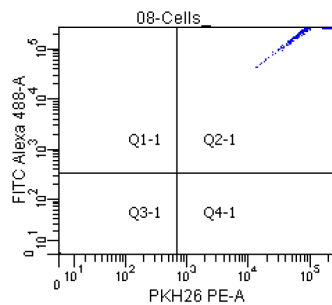
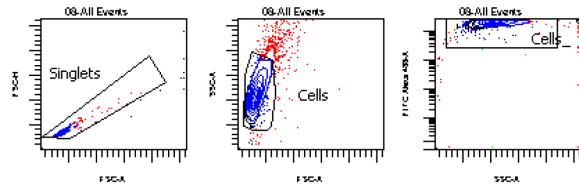
6) Flow cytometry data of mRBC-MSN without human RBC or PKH26 dye (run 2).



Experiment Name: 111026 Trewyn RBC FITC PKH
Tube Name: 07
Record Date: Oct 26, 2011 1:52:29 PM

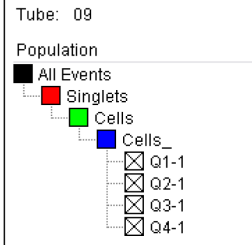
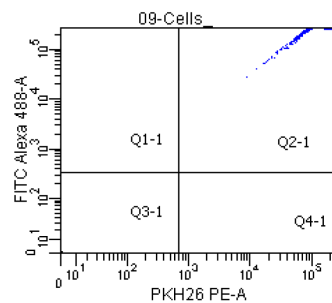
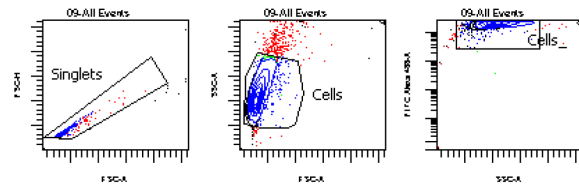
Population	#Events	%Parent	FITC Alexa 48... Median	PKH26 PE-A Median
<input checked="" type="checkbox"/> Q1	0	0.0	####	####
<input checked="" type="checkbox"/> Q2	8,650	100.0	244,831	92,327
<input checked="" type="checkbox"/> Q3	0	0.0	####	####
<input checked="" type="checkbox"/> Q4	0	0.0	####	####

7) Flow cytometry data of mRBC-MSN without human RBC or PKH26 dye (run 3).



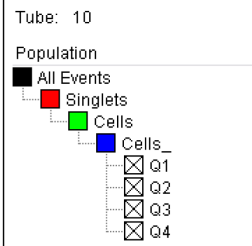
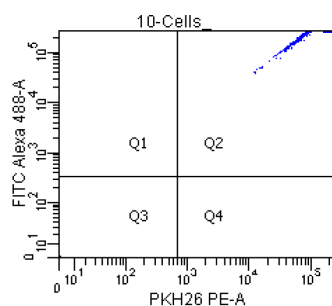
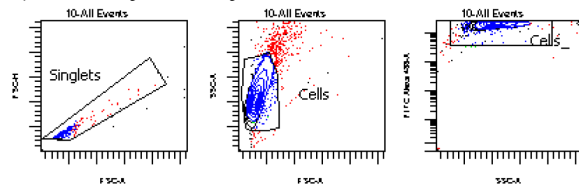
Experiment Name: 111026 Trewyn RBC FITC PKH				
Tube Name: 08				
Record Date: Oct 26, 2011 1:53:54 PM				
Population	#Events	%Parent	FITC Alexa 48... Median	PKH26 PE-A Median
<input checked="" type="checkbox"/> Q1-1	0	0.0	####	####
<input checked="" type="checkbox"/> Q2-1	3,644	100.0	254,558	105,238
<input checked="" type="checkbox"/> Q3-1	0	0.0	####	####
<input checked="" type="checkbox"/> Q4-1	0	0.0	####	####

8) Flow cytometry data of DPPC-MSN without human RBC or PKH26 dye (run 1).



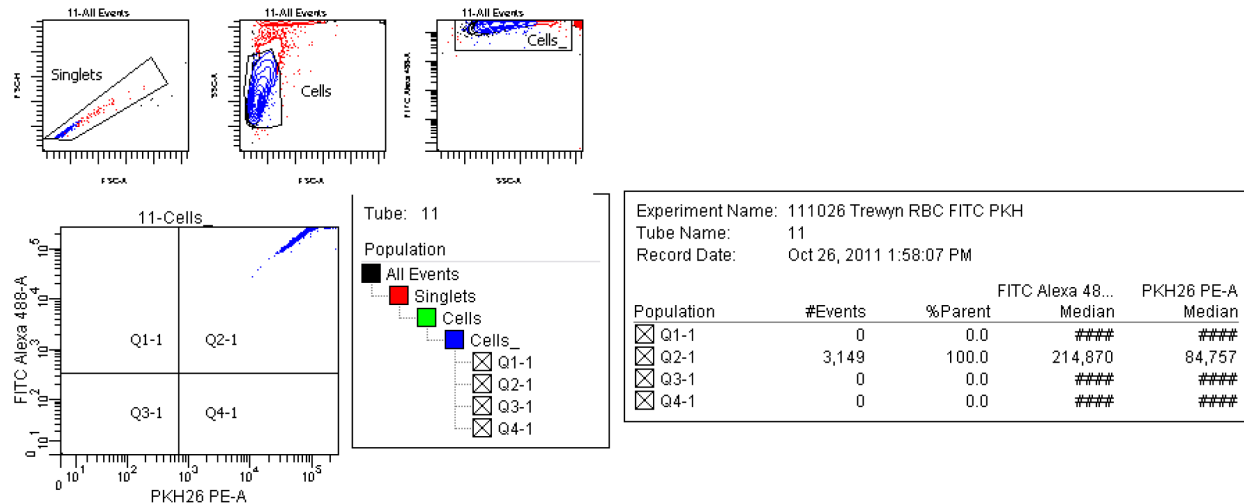
Experiment Name: 111026 Trewyn RBC FITC PKH				
Tube Name: 09				
Record Date: Oct 26, 2011 1:55:20 PM				
Population	#Events	%Parent	FITC Alexa 48... Median	PKH26 PE-A Median
<input checked="" type="checkbox"/> Q1-1	0	0.0	####	####
<input checked="" type="checkbox"/> Q2-1	3,768	100.0	254,418	104,868
<input checked="" type="checkbox"/> Q3-1	0	0.0	####	####
<input checked="" type="checkbox"/> Q4-1	0	0.0	####	####

9) Flow cytometry data of DPPC-MSN without human RBC or PKH26 dye (run 2).

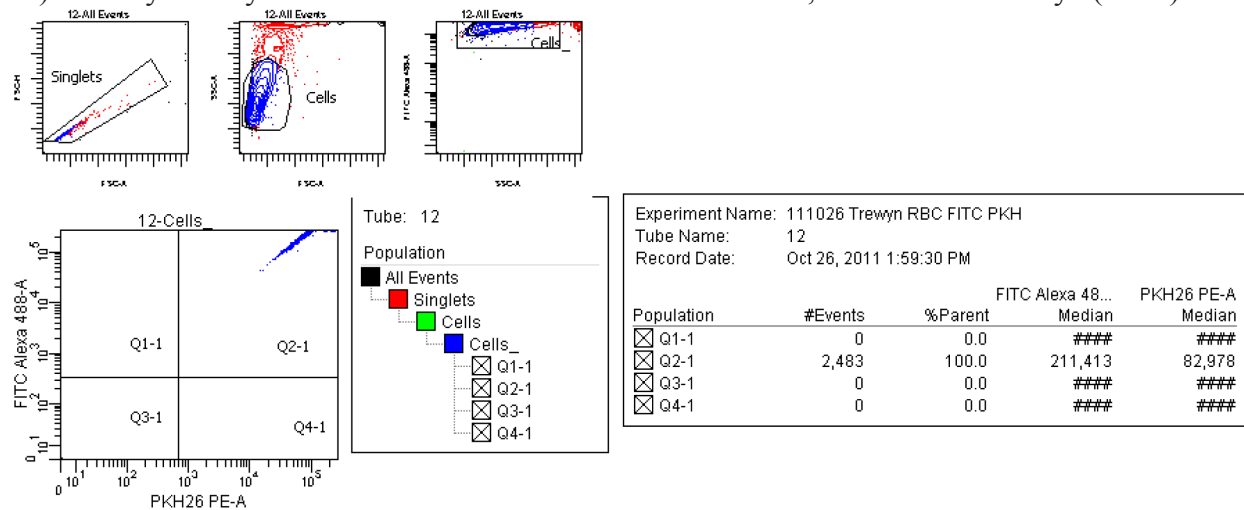


Experiment Name: 111026 Trewyn RBC FITC PKH				
Tube Name: 10				
Record Date: Oct 26, 2011 1:56:43 PM				
Population	#Events	%Parent	FITC Alexa 48... Median	PKH26 PE-A Median
<input checked="" type="checkbox"/> Q1	0	0.0	####	####
<input checked="" type="checkbox"/> Q2	4,516	100.0	254,480	104,329
<input checked="" type="checkbox"/> Q3	0	0.0	####	####
<input checked="" type="checkbox"/> Q4	0	0.0	####	####

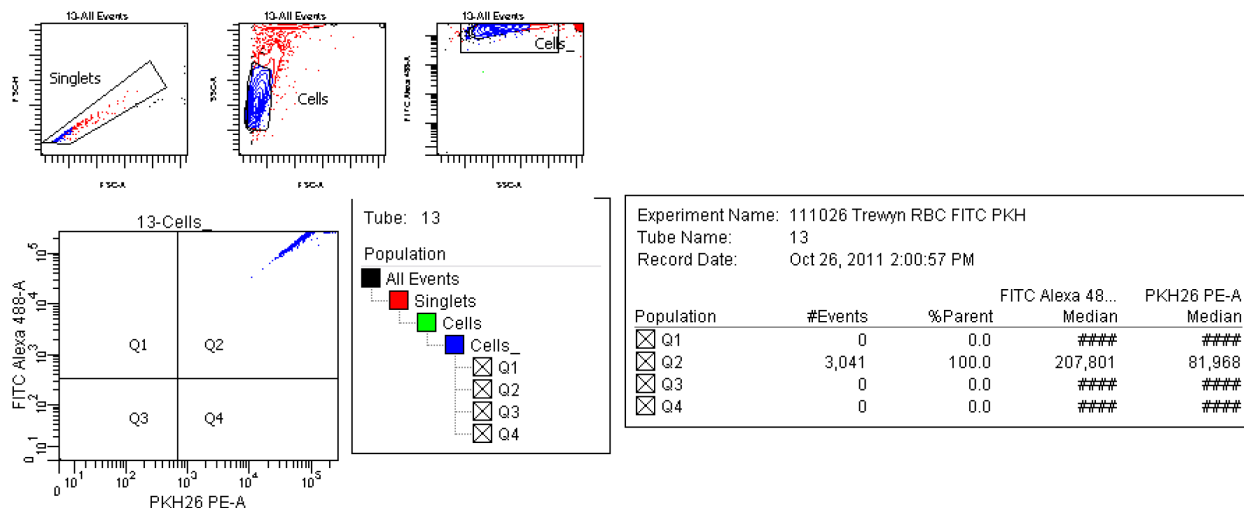
10) Flow cytometry data of DPPC-MSN without human RBC or PKH26 dye (run 3).



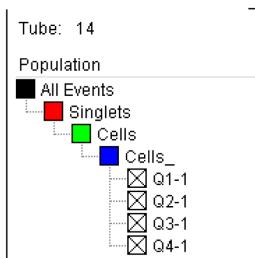
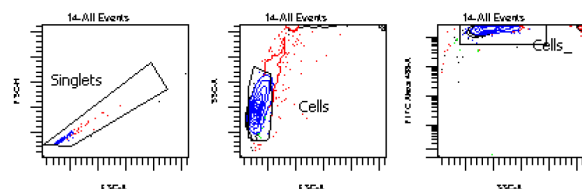
11) Flow cytometry data of mRBC-MSN without human RBC, but with PKH26 dye (run 1).



12) Flow cytometry data of mRBC-MSN without human RBC, but with PKH26 dye (run 2).



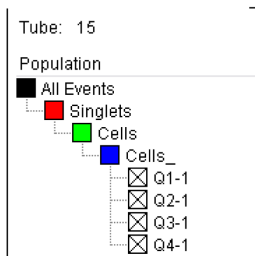
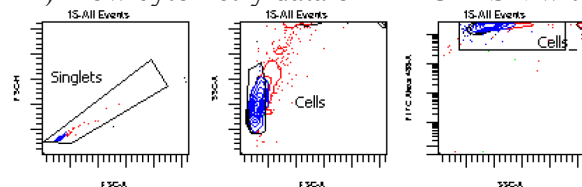
13) Flow cytometry data of mRBC-MSN without human RBC, but with PKH26 dye (run 3).



Experiment Name: 111026 Trewyn RBC FITC PKH
 Tube Name: 14
 Record Date: Oct 26, 2011 2:02:21 PM

Population	#Events	%Parent	FITC Alexa 48... Median	PKH26 PE-A Median
<input checked="" type="checkbox"/> Q1-1	0	0.0	####	####
<input checked="" type="checkbox"/> Q2-1	1,123	100.0	240,983	96,041
<input checked="" type="checkbox"/> Q3-1	0	0.0	####	####
<input checked="" type="checkbox"/> Q4-1	0	0.0	####	####

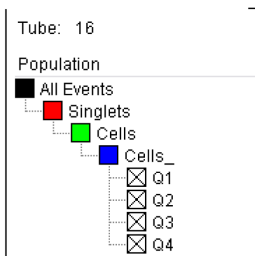
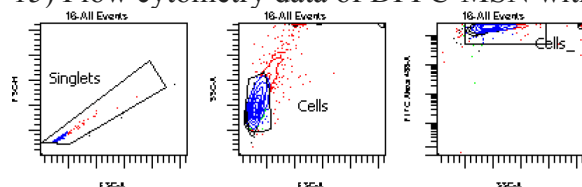
14) Flow cytometry data of DPPC-MSN without human RBC, but with PKH26 dye (run 1).



Experiment Name: 111026 Trewyn RBC FITC PKH
 Tube Name: 15
 Record Date: Oct 26, 2011 2:03:45 PM

Population	#Events	%Parent	FITC Alexa 48... Median	PKH26 PE-A Median
<input checked="" type="checkbox"/> Q1-1	0	0.0	####	####
<input checked="" type="checkbox"/> Q2-1	826	100.0	232,074	92,055
<input checked="" type="checkbox"/> Q3-1	0	0.0	####	####
<input checked="" type="checkbox"/> Q4-1	0	0.0	####	####

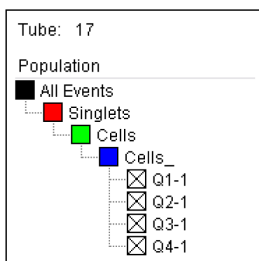
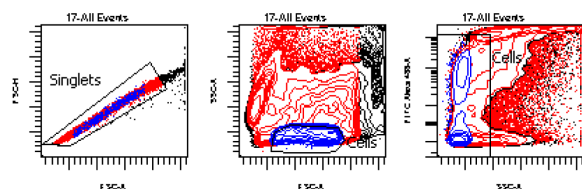
15) Flow cytometry data of DPPC-MSN without human RBC, but with PKH26 dye (run 2).



Experiment Name: 111026 Trewyn RBC FITC PKH
 Tube Name: 16
 Record Date: Oct 26, 2011 2:05:08 PM

Population	#Events	%Parent	FITC Alexa 48... Median	PKH26 PE-A Median
<input checked="" type="checkbox"/> Q1	0	0.0	####	####
<input checked="" type="checkbox"/> Q2	1,157	100.0	238,347	95,107
<input checked="" type="checkbox"/> Q3	0	0.0	####	####
<input checked="" type="checkbox"/> Q4	0	0.0	####	####

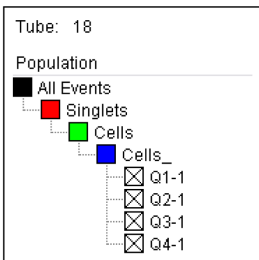
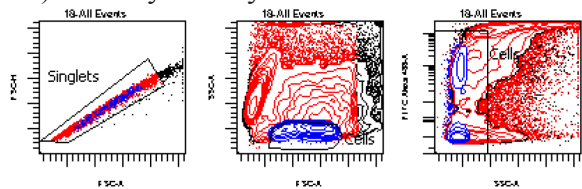
16) Flow cytometry data of DPPC-MSN without human RBC, but with PKH26 dye (run 3).



Experiment Name: 111026 Trewyn RBC FITC PKH
 Tube Name: 17
 Record Date: Oct 26, 2011 2:06:37 PM

Population	#Events	%Parent	FITC Alexa 48... Median	PKH26 PE-A Median
<input checked="" type="checkbox"/> Q1-1	2	0.0	802	583
<input checked="" type="checkbox"/> Q2-1	2,900	58.0	5,077	6,610
<input checked="" type="checkbox"/> Q3-1	28	0.6	-918	496
<input checked="" type="checkbox"/> Q4-1	2,073	41.4	-758	3,901

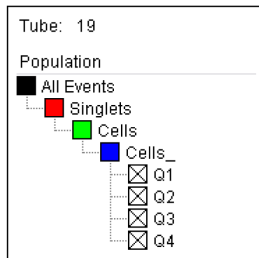
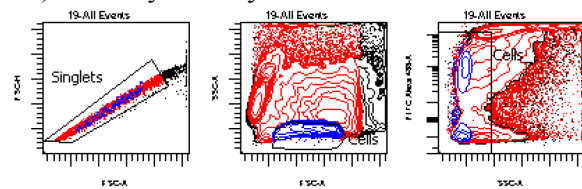
17) Flow cytometry data of mRBC-MSN with human RBC and PKH26 dye (run 1).



Experiment Name: 111026 Trewyn RBC FITC PKH
 Tube Name: 18
 Record Date: Oct 26, 2011 2:08:01 PM

Population	#Events	%Parent	FITC Alexa 48... Median	PKH26 PE-A Median
<input checked="" type="checkbox"/> Q1-1	0	0.0	####	####
<input checked="" type="checkbox"/> Q2-1	1,923	56.5	5,727	6,800
<input checked="" type="checkbox"/> Q3-1	21	0.6	-1,009	508
<input checked="" type="checkbox"/> Q4-1	1,457	42.8	-860	3,863

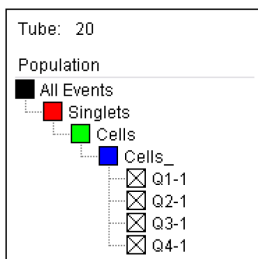
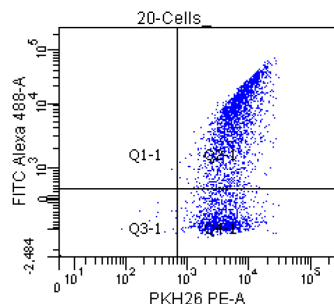
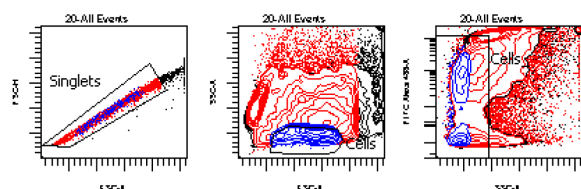
18) Flow cytometry data of mRBC-MSN with human RBC and PKH26 dye (run 2).



Experiment Name: 111026 Trewyn RBC FITC PKH
 Tube Name: 19
 Record Date: Oct 26, 2011 2:09:26 PM

Population	#Events	%Parent	FITC Alexa 48... Median	PKH26 PE-A Median
<input checked="" type="checkbox"/> Q1	1	0.0	1,831	392
<input checked="" type="checkbox"/> Q2	1,699	63.2	5,471	6,989
<input checked="" type="checkbox"/> Q3	9	0.3	-615	362
<input checked="" type="checkbox"/> Q4	978	36.4	-842	4,242

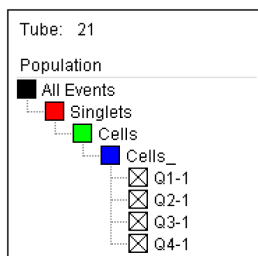
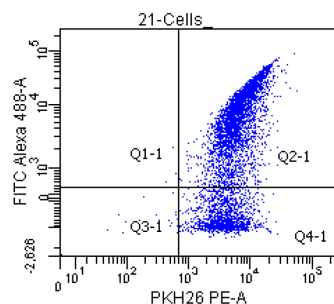
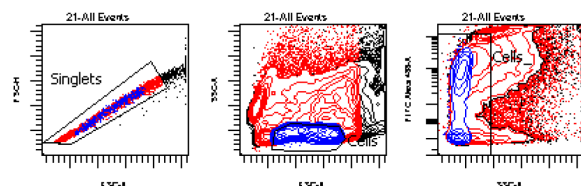
19) Flow cytometry data of mRBC-MSN with human RBC and PKH26 dye (run 3).



Experiment Name: 111026 Trewyn RBC FITC PKH
Tube Name: 20
Record Date: Oct 26, 2011 2:10:52 PM

Population	#Events	%Parent	FITC Alexa 48... Median	PKH26 PE-A Median
<input checked="" type="checkbox"/> Q1-1	1	0.0	909	558
<input checked="" type="checkbox"/> Q2-1	1,999	65.7	5,439	6,545
<input checked="" type="checkbox"/> Q3-1	12	0.4	-620	393
<input checked="" type="checkbox"/> Q4-1	1,030	33.9	-732	3,840

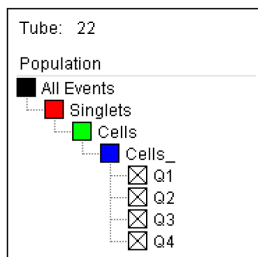
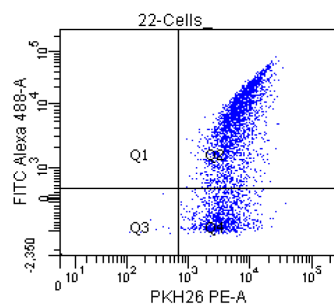
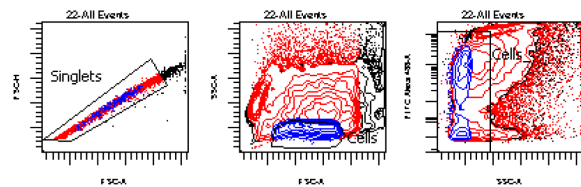
20) Flow cytometry data of DPPC-MSN with human RBC and PKH26 dye (run 1).



Experiment Name: 111026 Trewyn RBC FITC PKH
Tube Name: 21
Record Date: Oct 26, 2011 2:12:19 PM

Population	#Events	%Parent	FITC Alexa 48... Median	PKH26 PE-A Median
<input checked="" type="checkbox"/> Q1-1	3	0.1	754	563
<input checked="" type="checkbox"/> Q2-1	3,186	69.7	5,908	6,783
<input checked="" type="checkbox"/> Q3-1	21	0.5	-828	304
<input checked="" type="checkbox"/> Q4-1	1,364	29.8	-814	3,970

21) Flow cytometry data of DPPC-MSN with human RBC and PKH26 dye (run 2).

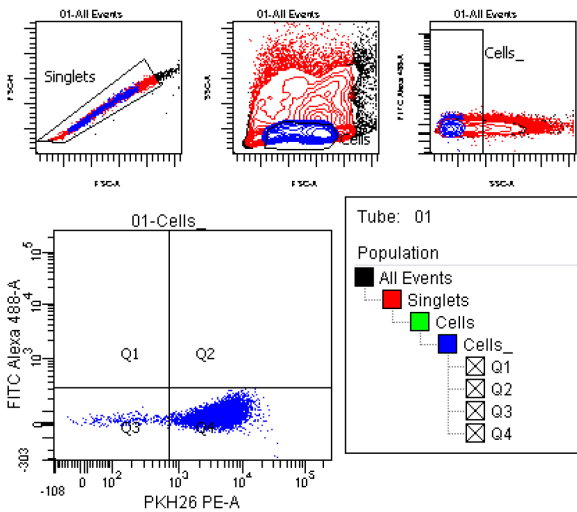


Experiment Name: 111026 Trewyn RBC FITC PKH
Tube Name: 22
Record Date: Oct 26, 2011 2:13:43 PM

Population	#Events	%Parent	FITC Alexa 48... Median	PKH26 PE-A Median
<input checked="" type="checkbox"/> Q1	0	0.0	###	###
<input checked="" type="checkbox"/> Q2	2,205	70.7	5,508	6,788
<input checked="" type="checkbox"/> Q3	12	0.4	-962	273
<input checked="" type="checkbox"/> Q4	902	28.9	-623	3,835

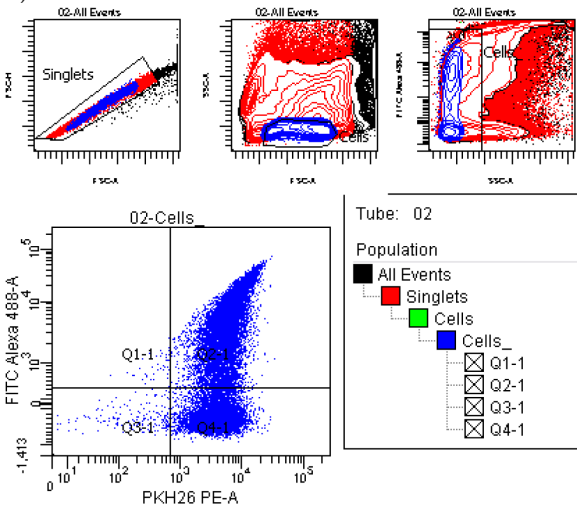
22) Flow cytometry data of DPPC-MSN with human RBC and PKH26 dye (run 3).

111019 Trewyn



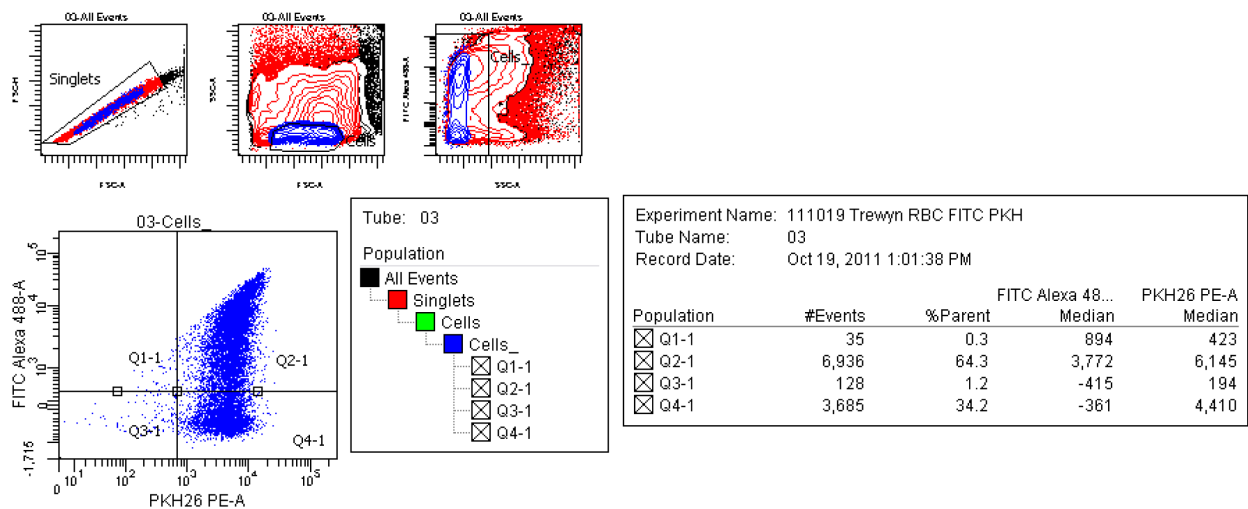
Experiment Name: 111019 Trewyn RBC FITC PKH				
Tube Name: 01				
Record Date: Oct 19, 2011 12:58:48 PM				
Population	#Events	%Parent	FITC Alexa 48... Median	PKH26 PE-A Median
<input checked="" type="checkbox"/> Q1	0	0.0	###	###
<input checked="" type="checkbox"/> Q2	0	0.0	###	###
<input checked="" type="checkbox"/> Q3	239	3.1	20	187
<input checked="" type="checkbox"/> Q4	7,589	96.9	55	4,626

1) Control



Experiment Name: 111019 Trewyn RBC FITC PKH				
Tube Name: 02				
Record Date: Oct 19, 2011 1:00:14 PM				
Population	#Events	%Parent	FITC Alexa 48... Median	PKH26 PE-A Median
<input checked="" type="checkbox"/> Q1-1	42	0.2	788	464
<input checked="" type="checkbox"/> Q2-1	9,449	54.2	3,559	6,134
<input checked="" type="checkbox"/> Q3-1	247	1.4	-392	126
<input checked="" type="checkbox"/> Q4-1	7,711	44.2	-348	4,433

2) Flow cytometry data of molecular DPPC with human RBC and PKH26 dye.



3) Flow cytometry data of molecular mRBC with human RBC and PKH26 dye.

(1) Khairy, K.; Foo, J.; Howard, J. *Cel. Mol. Bioeng.* **2008**, *1*, 173.