Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information:

The Role of Particle-to-Cell Interactions in Dictating the Nanoparticle Aided Magnetophoretic Separation of Microalgal Cell

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Table S1. Contact angle measurements of *Chlorella* sp., bare-IONPs, SF-IONPs and the *Nannochloropsis* sp in three different liquid.

Surface	Contact Angle (°)		
	Water	Glycerol	1-Bromonaphthalene
Chlorella sp.	42.7 ± 1.7	85.1 ± 0.7	65.5 ± 4.9
Bare-IONPs	7.4 ± 0.9	49.5 ± 2.7	8.2 ± 0.2
SF-IONPs	12.5 ± 0.9	40.5 ± 2.6	11.6 ± 1.1
Nannochloropsis sp.	17.0 ± 1.1	50.7 ± 1.1	57.6 ± 1.9

Table S2. Surface energy components of the liquids that used for contact angle measurements to predict the Hamaker constant of two interacting surfaces.

	Surface Energy (mJ/m^2)				
	γ^{tot}	γ^{LW}	γ^{AB}	$\gamma^{\oplus}$	$\gamma^{\ominus}$
Water	72.8	21.8	51.0	25.5	25.5
Glycerol	64.0	34	30.0	3.92	57.4
1-Bromonaphthalene	44.4	44.4	0	0	0

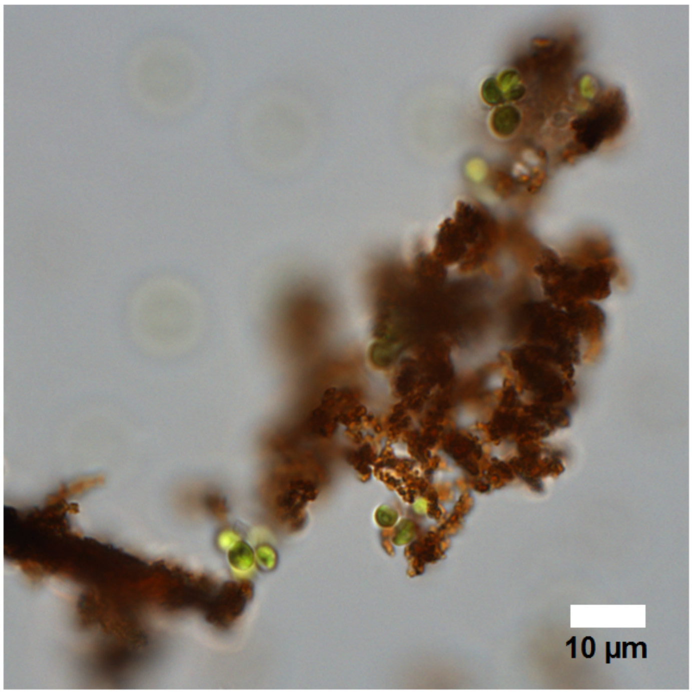

Figure S1. Optical microscopy image show some of the *Chlorella* sp. cells are trapped inside the flocculated bare-IONPs matrix after introduced the permanent magnet NdFeB.

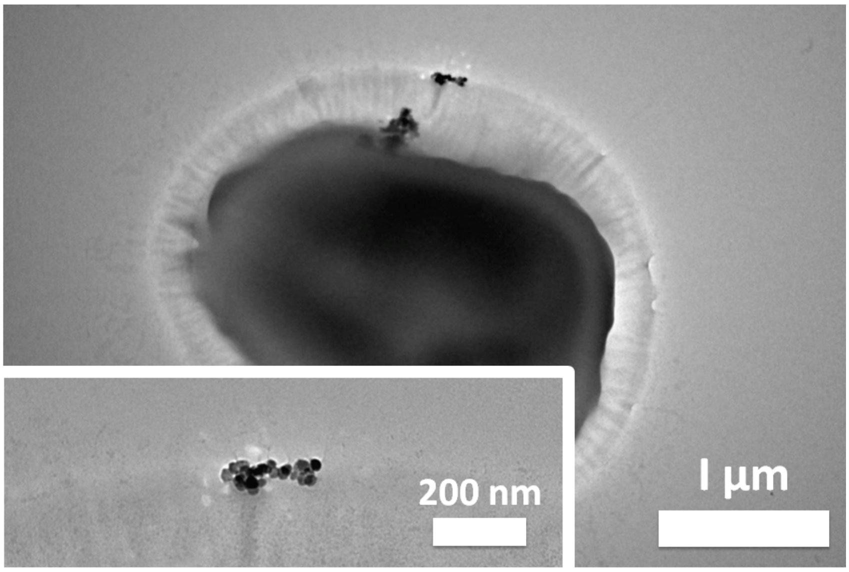

Figure S2. Transmission electron microscopy (TEM) micrograph shows relatively small size of the IONPs with respect to the *Chlorella* sp. cell surface. The cell surface is assumed to be a flat surface for the interaction with IONPs.

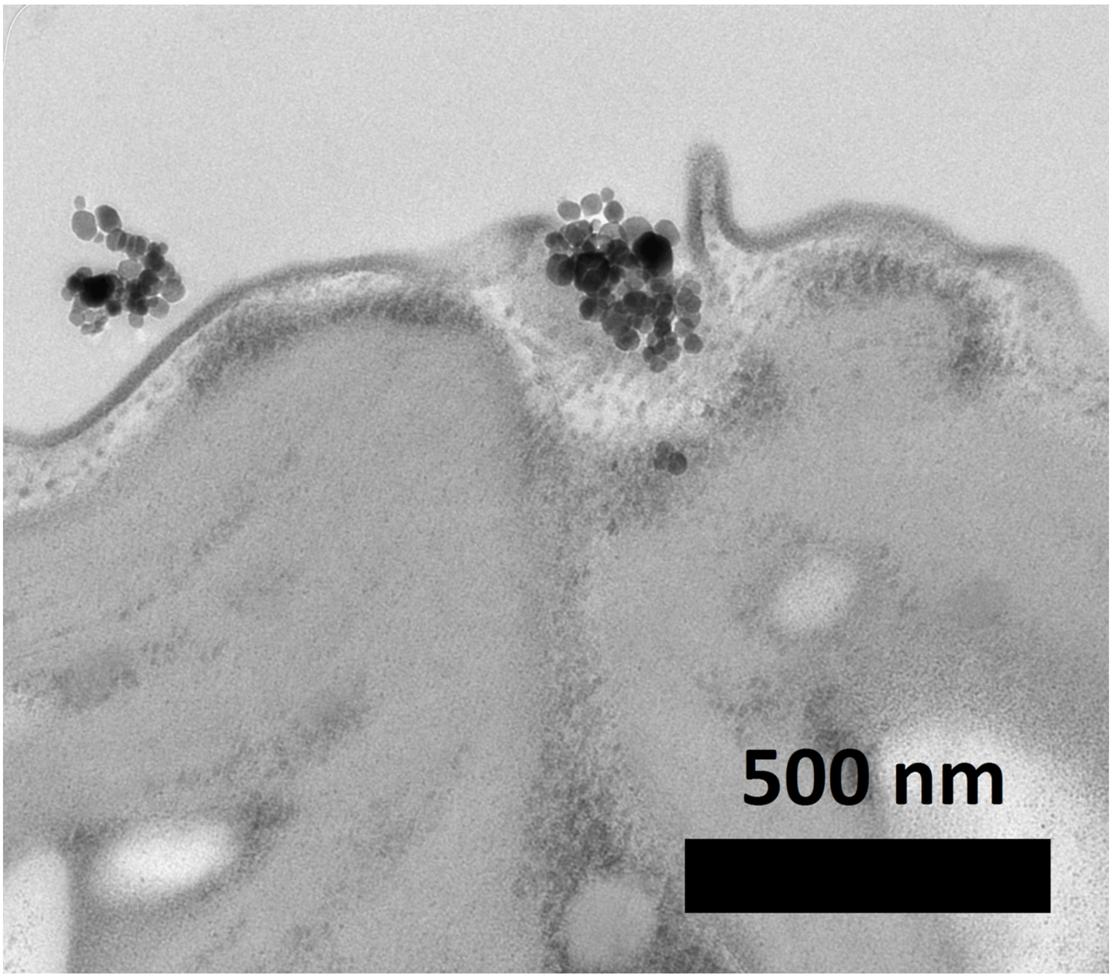

Figure S3. TEM micrograph shows the successfully attachment of the SF-IONPs (positive charge) onto the cell membrane (net negative charge) of *Chlorella* sp. through the ES attraction. Coincidentally, this micrograph has also revealed the internalization of SF-IONPs into the microalgal cell.

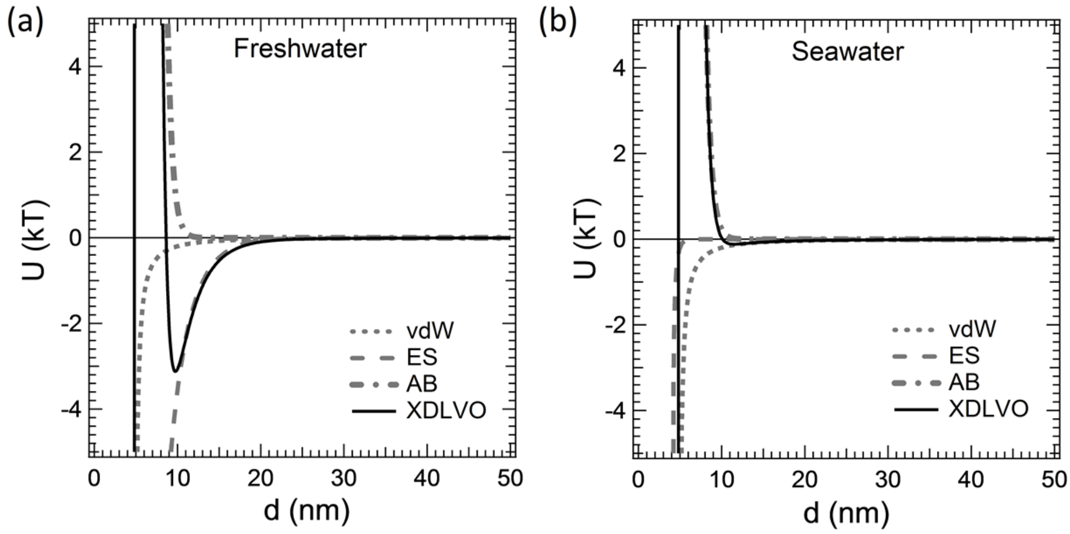

Figure S4. The XDLVO profile for the interaction between the *Chlorella* sp. cells and the SF-IONPs in (a) freshwater and (b) seawater.

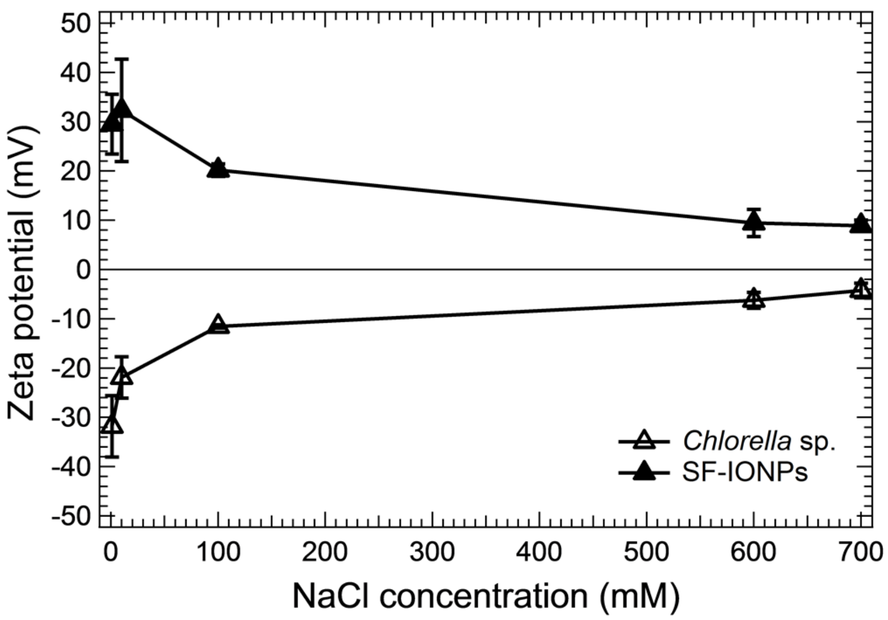

Figure S5. Zeta potential of *Chlorella* sp. and SF-IONPs with respect to NaCl concentration.

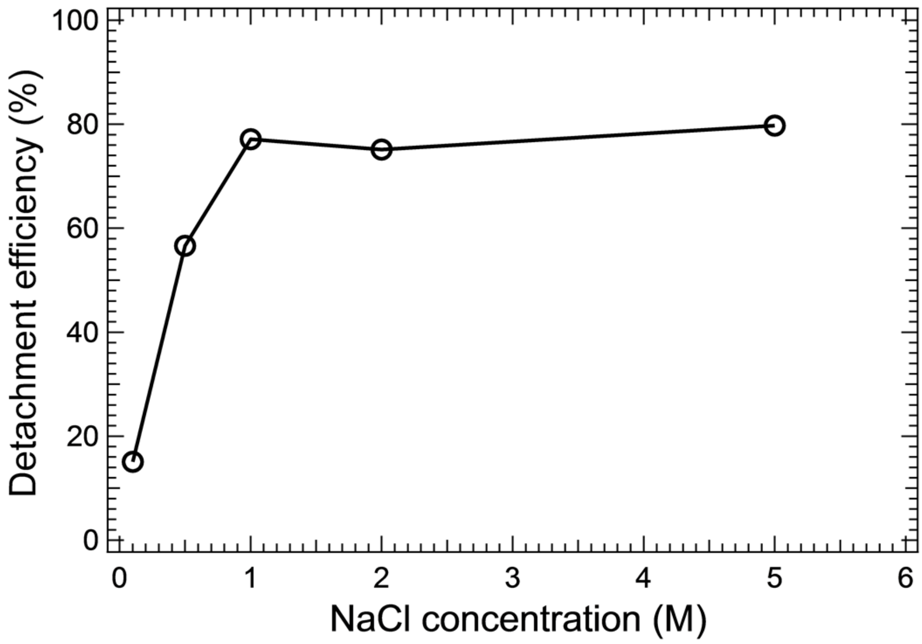

Figure S6. Detachment efficiency of *Chlorella* sp. cells from the SF-IONPs-attached-cells biomass in different concentration of NaCl.

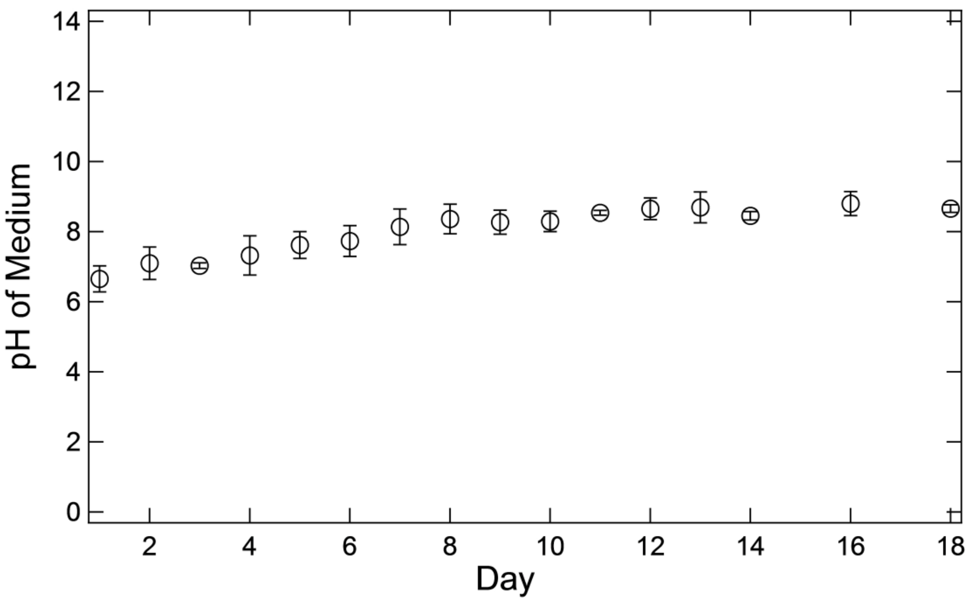

Figure S7. The solution pH of the *Chlorella* sp. culture medium has increased slightly within the culturing period. The range of pH fluctuation can be observed between pH 6 to pH 9. (Reference: Toh, P. Y.; Ng, B. W.; Ahmad, A. L.; Derek, C. J. C.; Lim, J. K. Magnetophoretic separation of *Chlorella* sp.: Role of cationic polymer binder. *Process Saf. Environ*. **2014**, http://dx.doi.org/10.1016/j.psep.2014.03.010.)

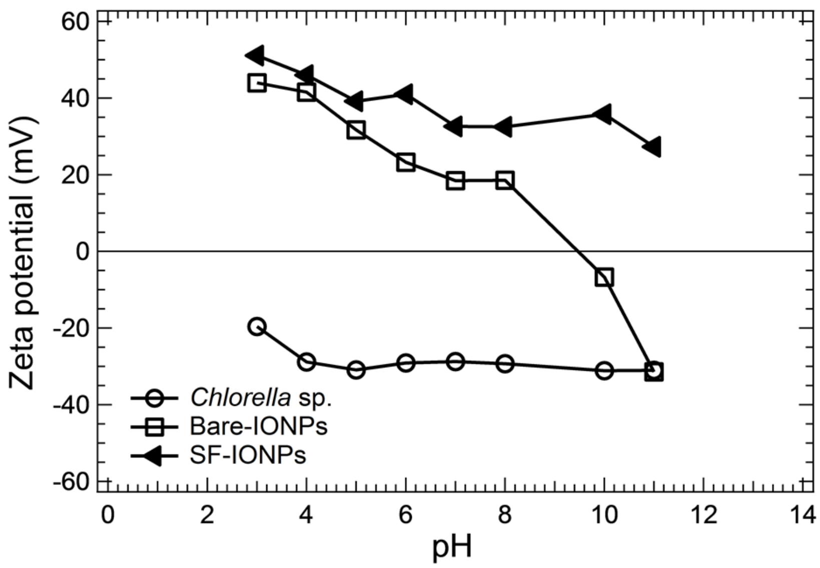

Figure S8. Zeta-potential of *Chlorella* sp., bare-IONPs and SF-IONPs as a function of solution pH.

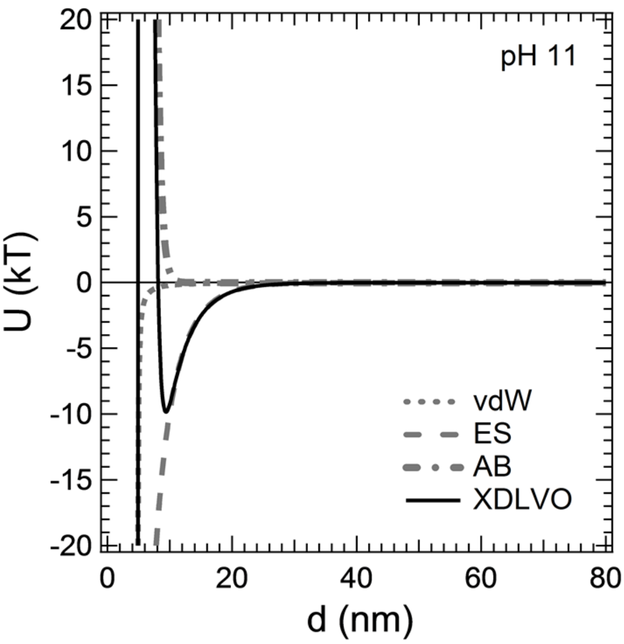

Figure S9. Potential energy profiles of vdW, ES, AB and XDLVO as a function of distance for the case of *Chlorella* sp. cells and SF-IONPs at pH 11.

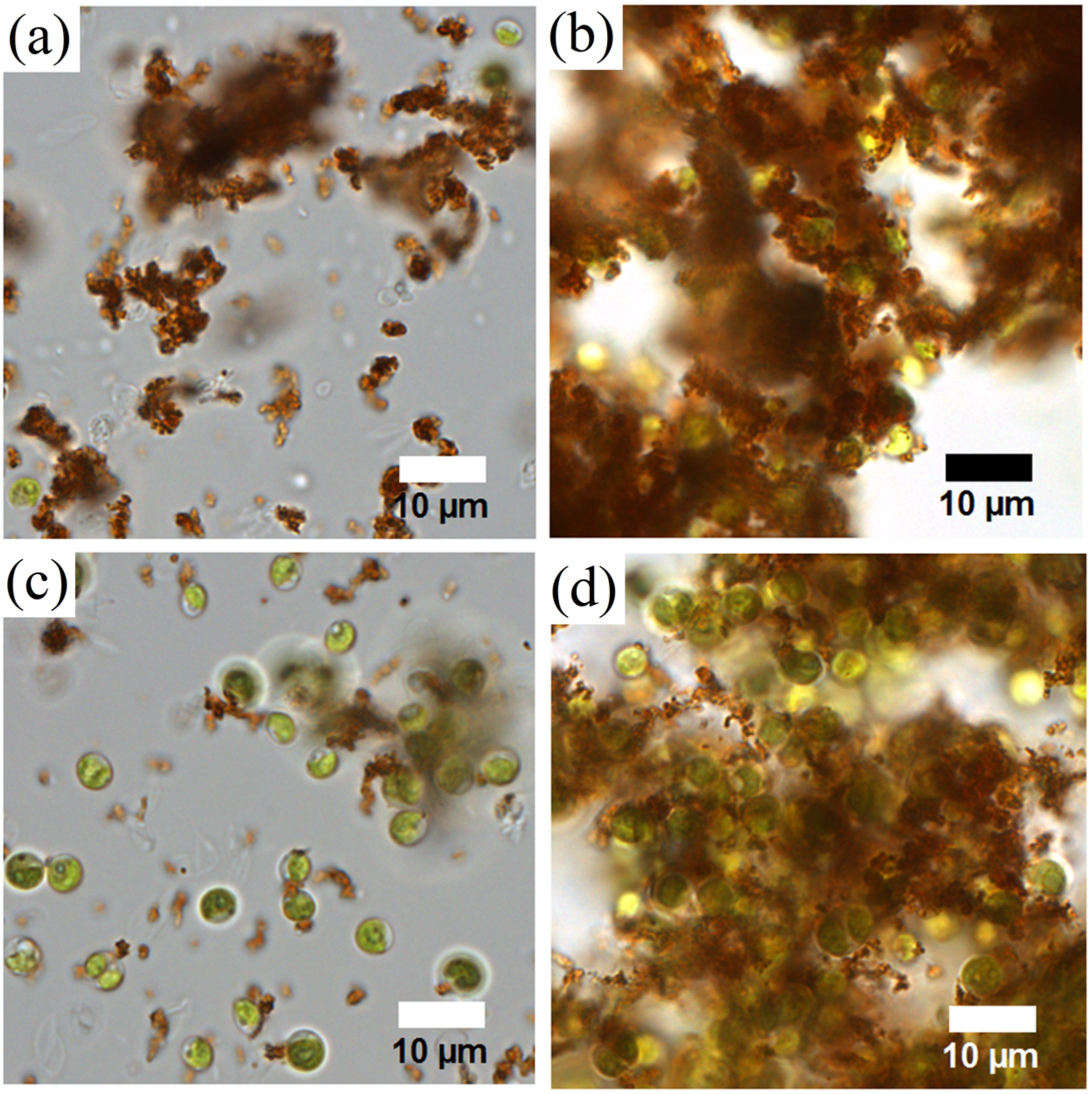

Figure S10. Bare-IONPs with particle-to-cell ratio of (a) 0.42 g g^{-1} and (b) 2.11 g g^{-1}, and SF-IONPs at with particle-to-cell ratio of (c) 0.21 g g^{-1} and (d) 0.42 g g^{-1} for the case of *Nannochloropsis* sp.. At the same particle-to-cell ratio of 0.42 g g^{-1} considerable seeding of SF-IONPs on microalgal cell can be observed but most of the bare-IONPs self-aggregated to form large clusters.

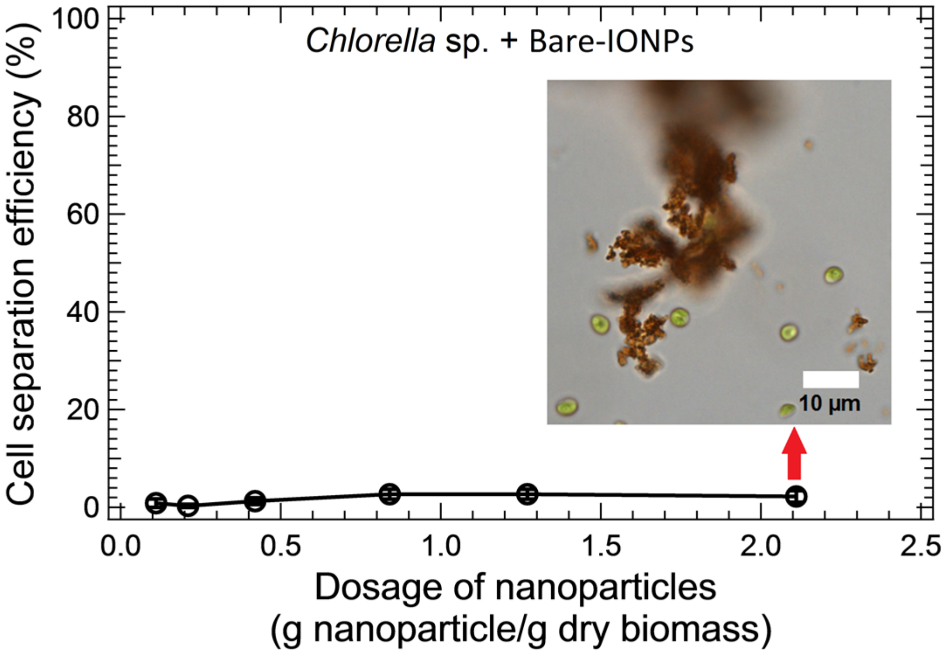

Figure S11. Magnetophoretic *Chlorella* sp. cell separation efficiency in different dosage of bare-IONPs. Microscopy image attached showed that there is no effective attachment between the cells and bare-IONPs even at high dosage of 2.11 g nanoparticles/g dry biomass.