



Supporting Information

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Single-Use, Metabolite Absorbing, Resonant Transducer (SMART) Culture Vessels for Label-Free, Continuous Cell Culture Progression Monitoring

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Table of Contents

Figure S1. Example of s-parameters response over frequency	3
Figure S2. Cross sectional side view of simulation of the resonant sensor system to investigate sensitivity to changing permittivity of a thin layer	4
Figure S3. Sensitivity of a wire wound resonant sensor of length 23 cm to polyethylene beads during resuspension events	5
Figure S4. Sensitivity of resonant sensor to suspending polyethylene beads.....	6
Figure S5. Screening of molecules containing different functional groups	7
Figure S6. SMART equilibrium response to the initial addition of culture media	8
Figure S7. SMART response to fetal bovine serum.....	9
Figure S8. SMART response to liposome	10
Figure S9. Differential Scanning Calorimetry and Thermogravimetric Analysis of polyacrylate after treatment with media or cells suspension	11
Figure S10. Frugal microscopic imaging system integrated with resonant sensor readout antenna.....	12
Figure S11. Resonant frequency profile with media exchange	13
Figure S12. Correlation between resonant frequency change and seeding concentration of HeLa cells	14
Figure S13. Resonant frequency profiles of HeLa cell culture under different concentrations of fetal bovine serum.....	15
Figure S14. Microscopic images of HeLa cells at different time of culture and corresponding annotated images.....	16
Figure S15. Correlation between resonant frequency change and seeding concentration of K562 cells.....	17
Figure S16. Resonant frequency profiles of Chinese hamster ovary cells in shaker flasks .	18
Table S1. Formulation of screening solutions	19

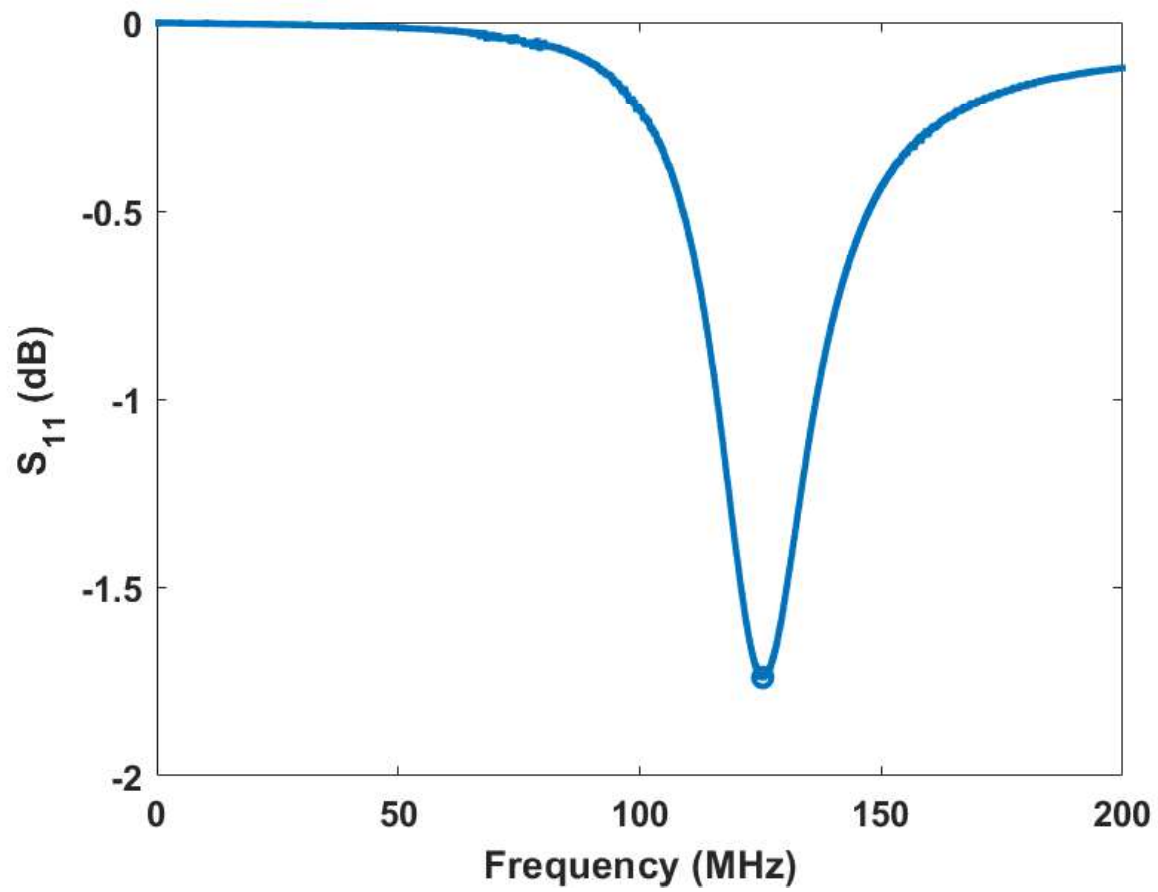


Figure S1. Example of s-parameters response over frequency. Resonant frequency is circled and determined from the spectrum minima.

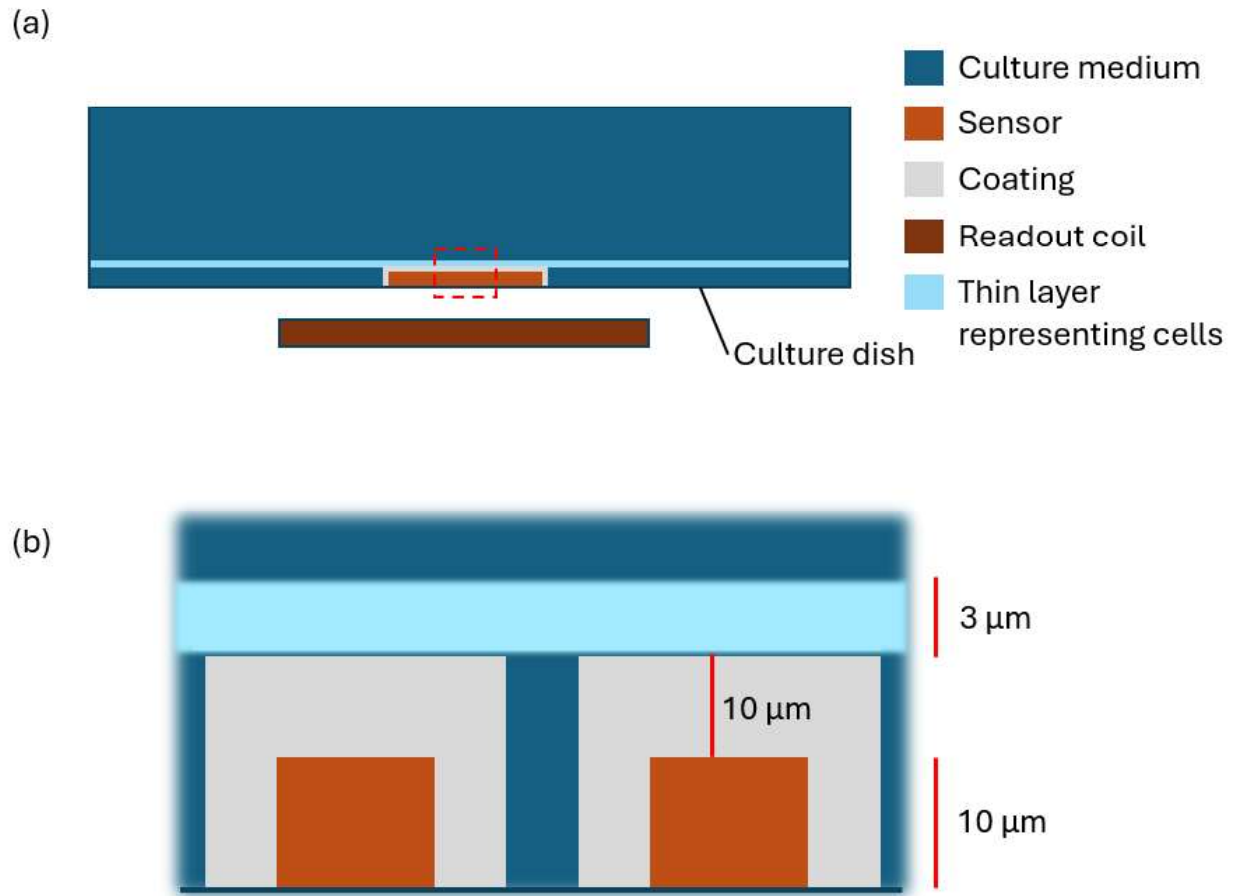


Figure S2. (a) Cross sectional side view of simulation of the resonant sensor system (see parameters below) to investigate sensitivity to changing permittivity of a thin layer (not to scale). Thin layer height: $3\mu\text{m}$; Dish height: 10mm ; Sensor height: $10\mu\text{m}$. (b) Enlarged view of the boxed region in (a), not to scale.

Simulation parameters:

Coating permittivity: 3

Coating conductivity: 0

Thin layer permittivity: 10-90

Thin layer conductivity: 0

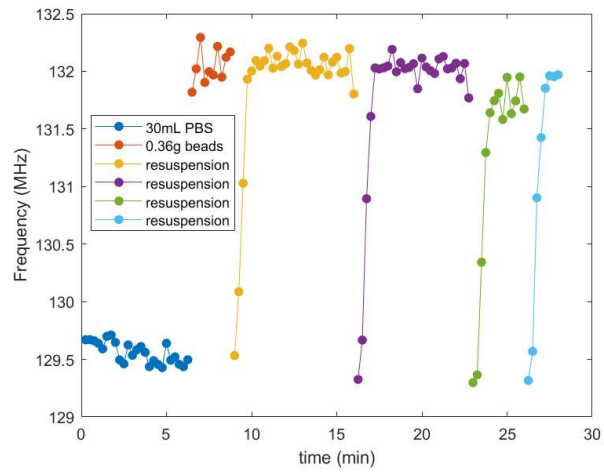


Figure S3. Sensitivity of a wire wound resonant sensor of length 23 cm to polyethylene beads during resuspension events. Resonant sensor was insulated with a 63.5 μ m Kapton.

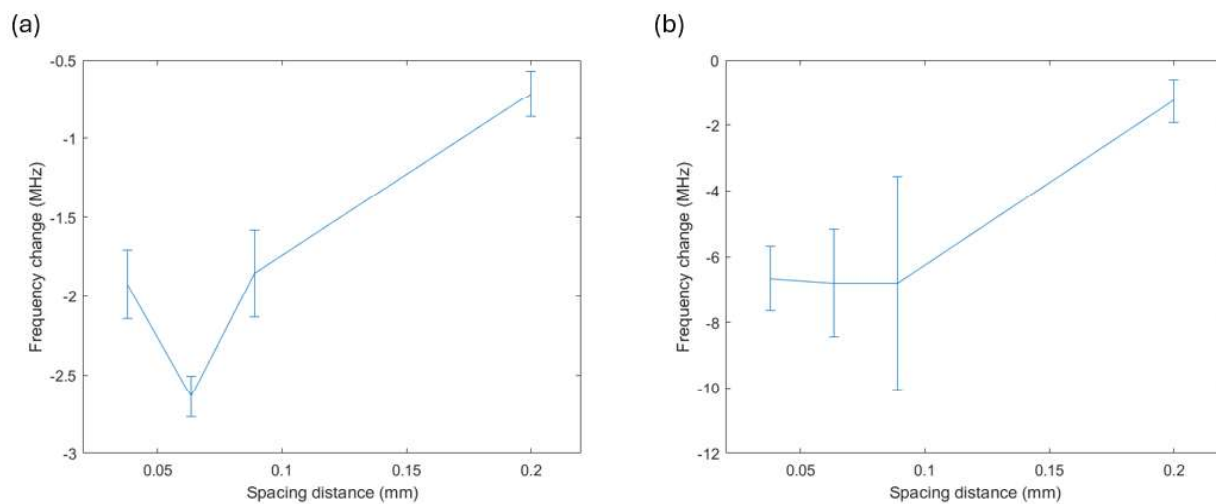


Figure S4. Sensitivity of resonant sensor to suspending polyethylene beads with (a) 23 cm wound wire and (b) 15 cm wound wire.

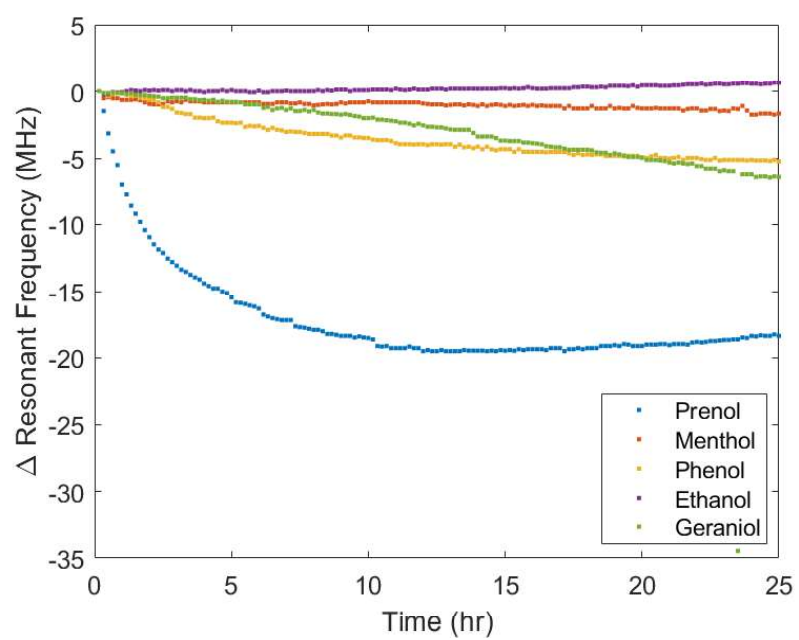


Figure S5. Screening of molecules containing different functional groups.

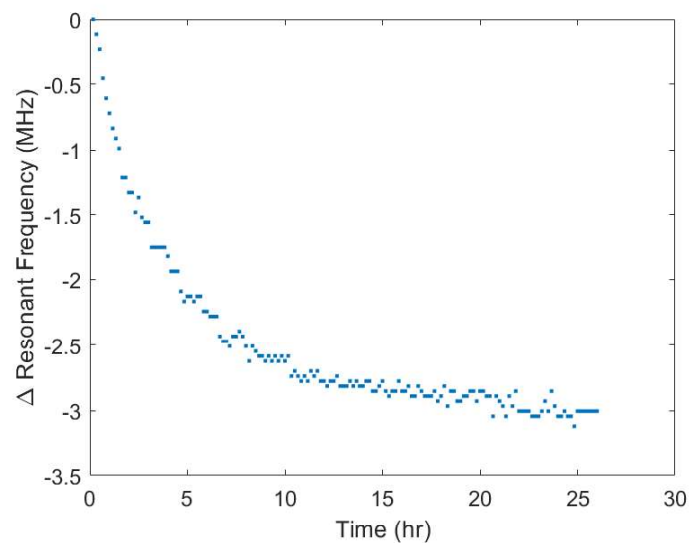


Figure S6. SMART equilibrium response to the initial addition of culture media.

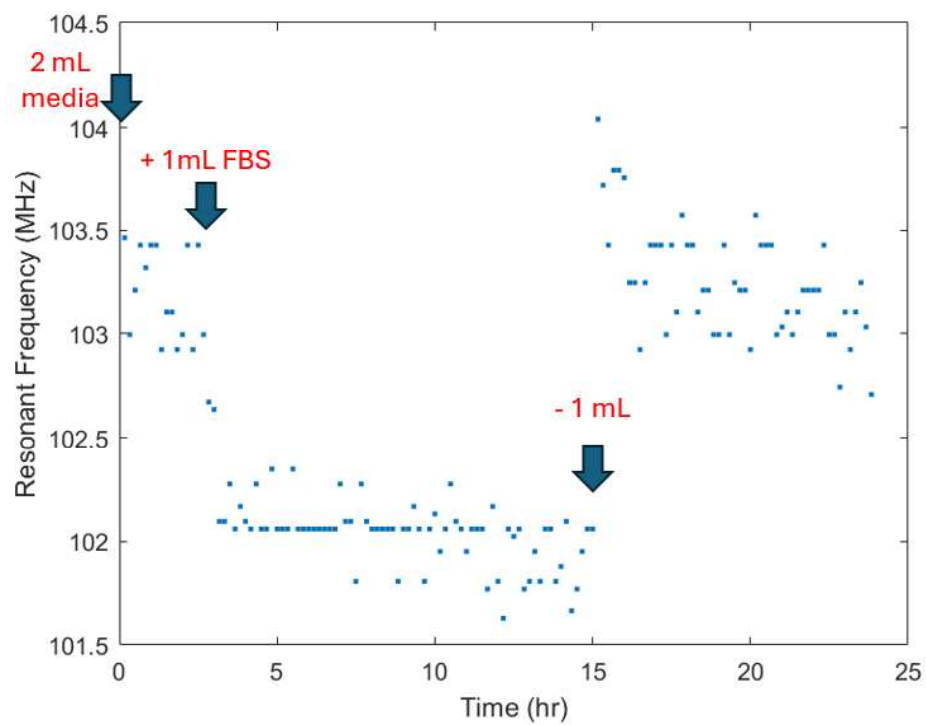


Figure S7. SMART response to fetal bovine serum (FBS). SMART was pre-equilibrated with culture media. Signal response after FBS addition is mainly due to increased media volume, as noted by return of signal upon solution removal.

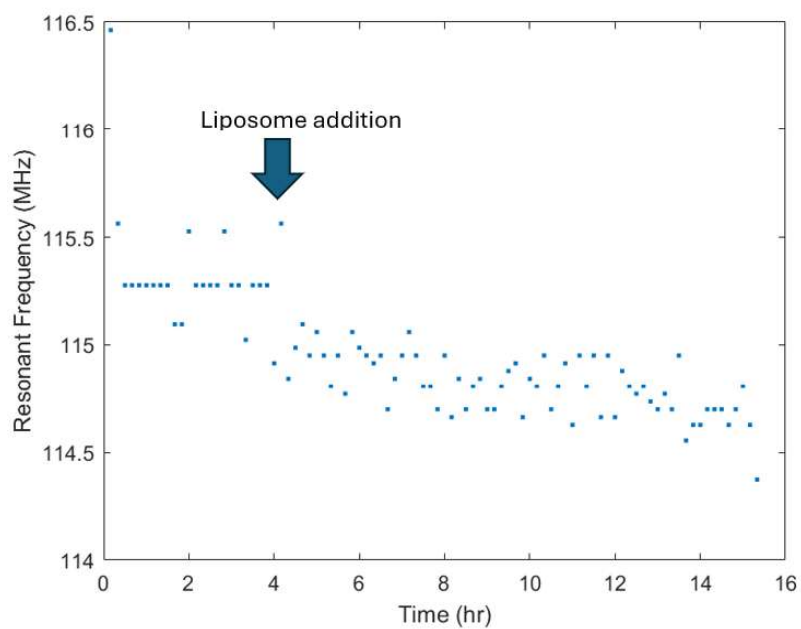


Figure S8. SMART response to liposome. SMART was pre-equilibrated with culture media.

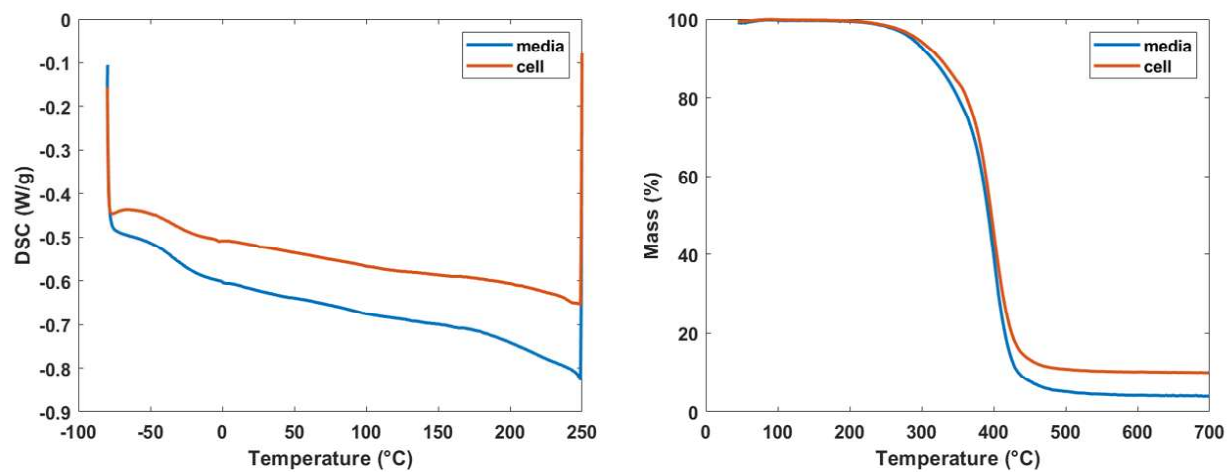


Figure S9. (Left) Differential Scanning Calorimetry and (Right) Thermogravimetric Analysis of polyacrylate after treatment with media or cells suspension.

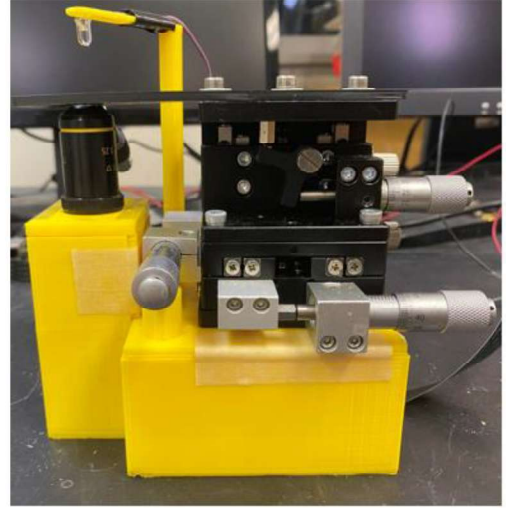
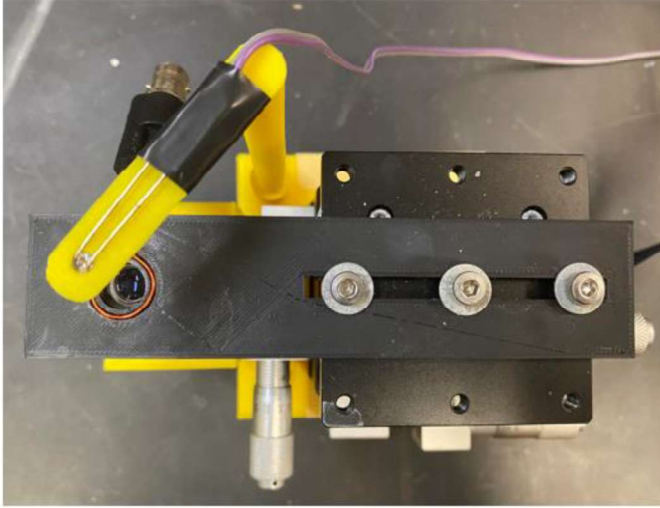


Figure S10. (Left) Top view and (Right) Side view of the frugal microscopic imaging system integrated with resonant sensor readout antenna.

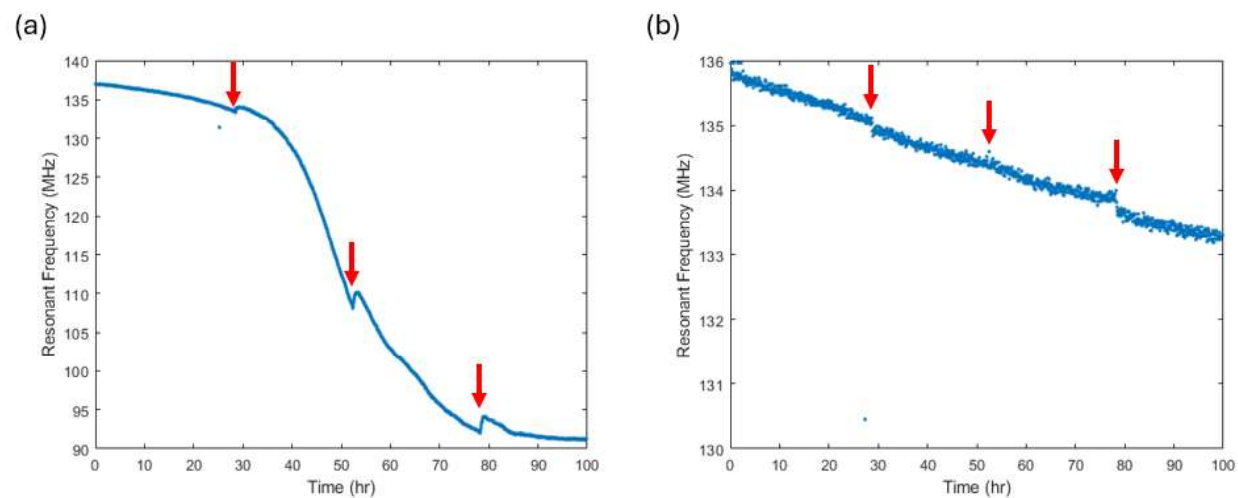


Figure S11. (a) Resonant frequency profile with media exchange at time points indicated by red arrows. (b) Resonant frequency profile of SMART dish containing only fresh media or spent media from (a) without cells.

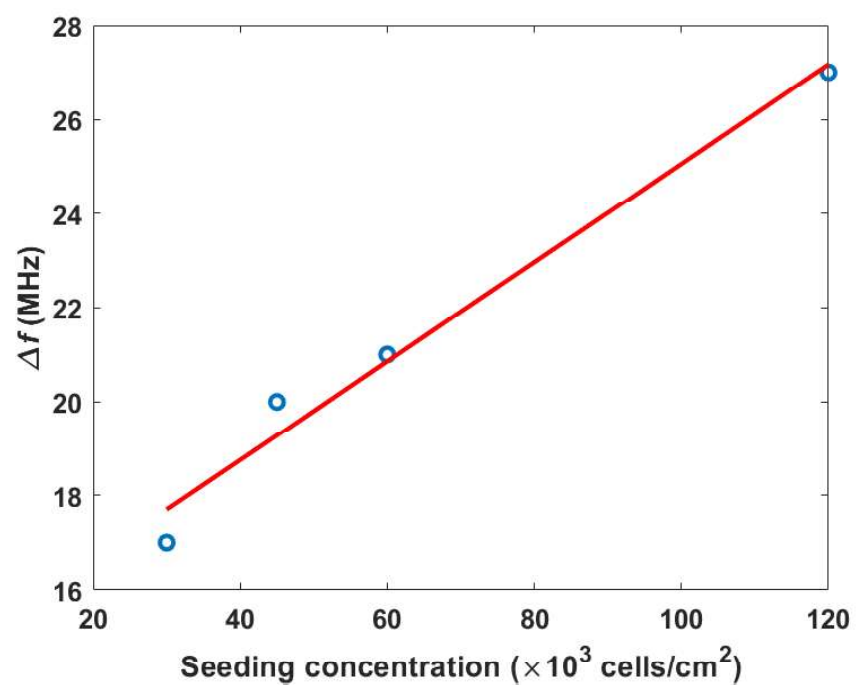


Figure S12. Correlation between resonant frequency change and seeding concentration of HeLa cells. Gain = 0.105MHz/1000cells/cm². $R^2 = 0.98$.

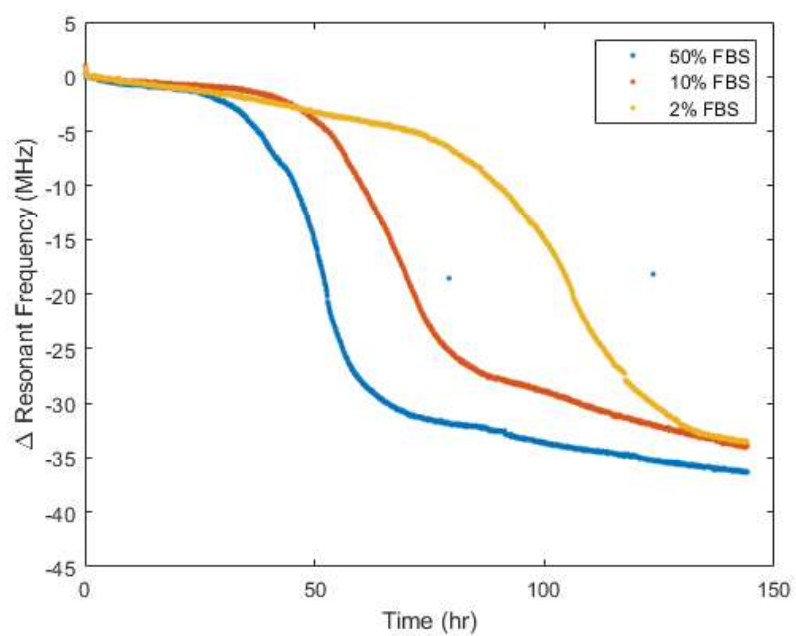


Figure S13. Resonant frequency profiles of HeLa cell culture under different concentrations of fetal bovine serum.

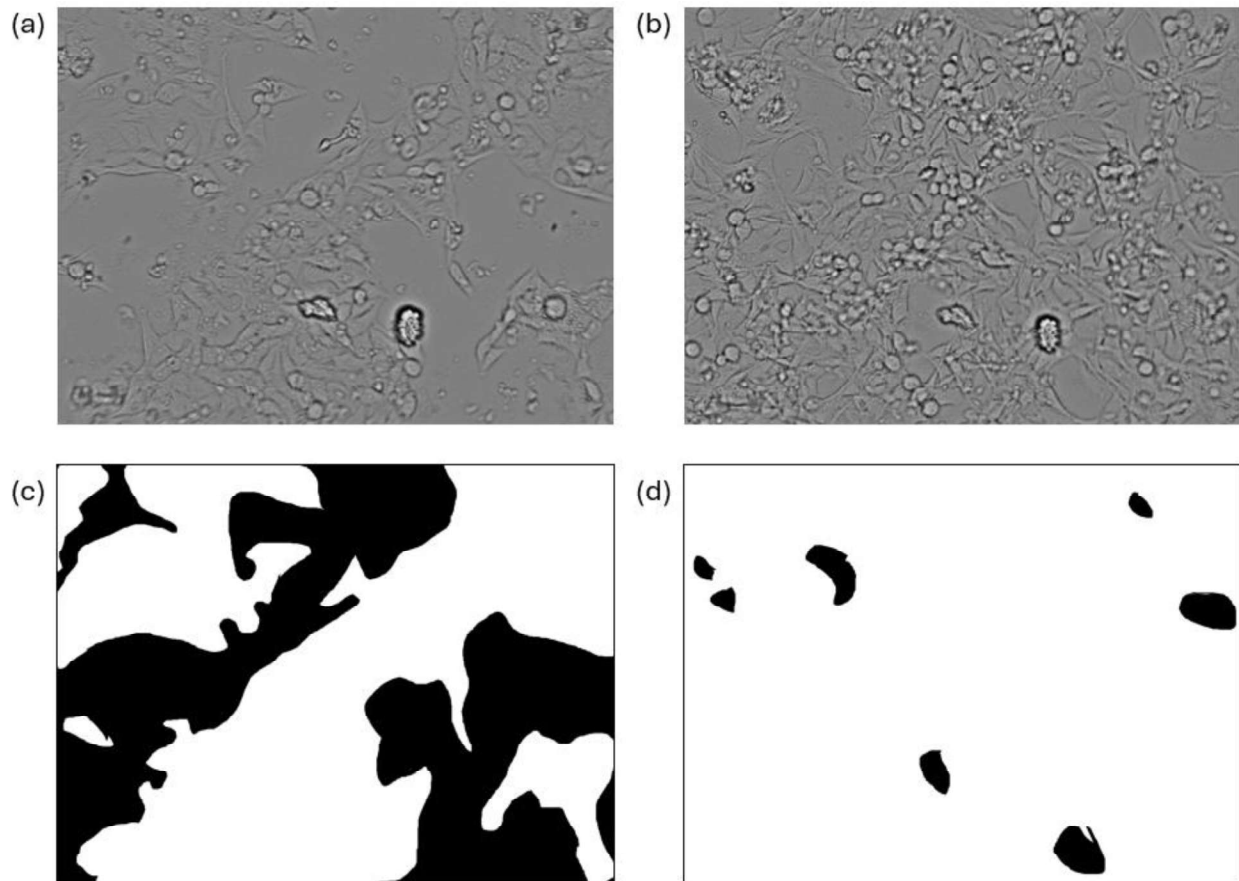


Figure S14. (a), (b) Microscopic images of HeLa cells at different time of culture and (c), (d) corresponding annotated images. White pixels represent cells whereas black pixels represent background.

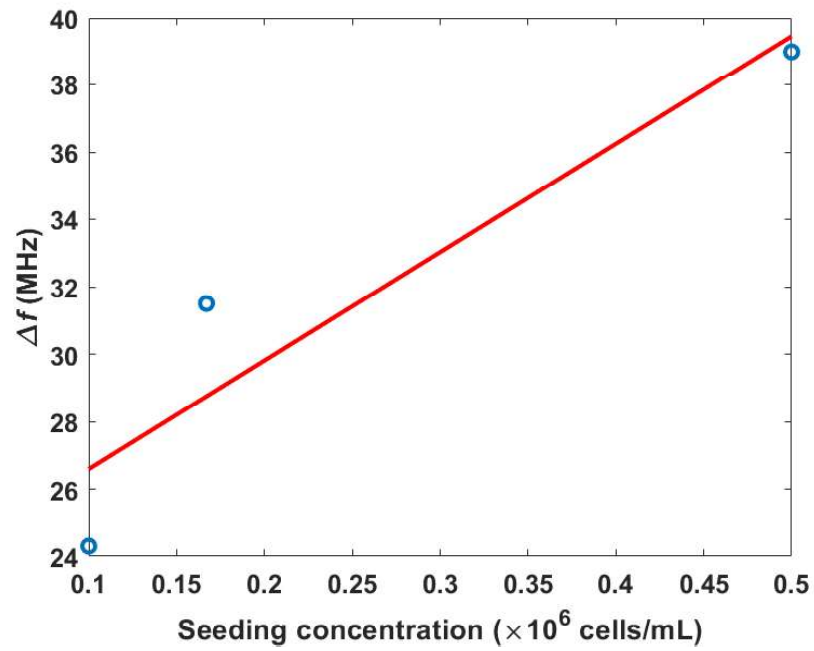


Figure S15. Correlation between resonant frequency change and seeding concentration of K562 cells. Gain = 0.032MHz/1000cells/mL. $R^2 = 0.88$.

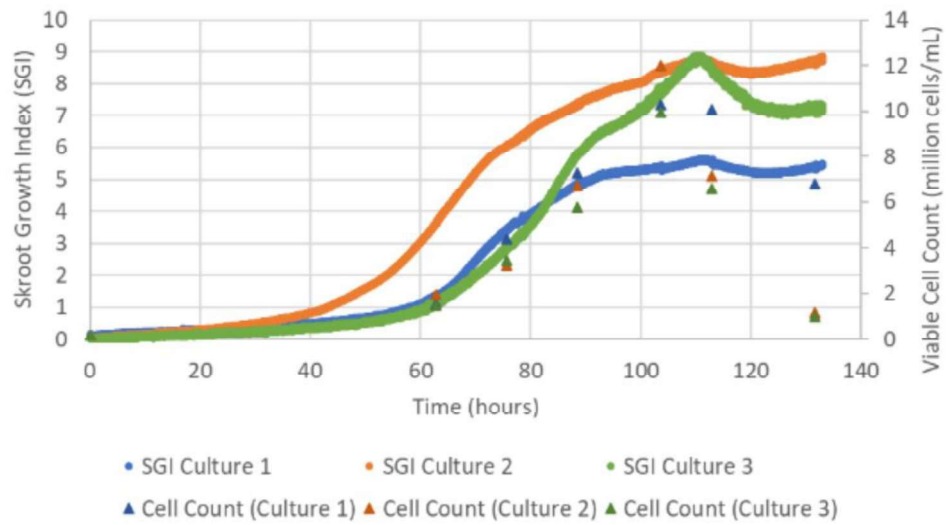


Figure S16. Resonant frequency profiles (represented in Skroot Growth Index) of Chinese hamster ovary cells in shaker flasks cultured in 80mL FreeStyle media, 37°C, 5% CO₂, and 120 RPM.

Table S1. Formulation of screening solutions

Chemical	Solvent	Concentration	Volume added (7mL total volume)
Lactic acid	-	>90 wt%	1 μ L
Ethanol	-	100 %	700 μ L
Phenol	Ethanol	200 mg/mL	700 μ L
Quinine hemisulfate	Ethanol	8.6 mg/mL	700 μ L
Pyridine hydrochloride	Ethanol	50 mg/mL	700 μ L
Trigonelline hydrochloride	Water	50 mg/mL	700 μ L
Hydroxyanthraquinone	Ethanol	2 mg/mL	700 μ L
Erythromycin	Ethanol	50 mg/mL	700 μ L
Amphotericin	Water	250 μ g/mL	700 μ L
Menthol	Ethanol	100 mg/mL	700 μ L
Geraniol	-	98%	700 μ L
Prenol	-	99%	700 μ L
Spent media	-	-	Replaced with 7 mL
Fetal bovine serum	-	-	1 mL
Liposome	Phosphate-buffered saline	4:1 Dipalmitoylphosphatidylcholine/ Cholesterol	500 μ L (2.5 mL total volume)