

## SUPPORTING INFORMATION

Review

# Recent Approaches in Magnetic Nanoparticle-based Biosensors of miRNA Detection

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**Table S1.** Literature survey of the MNP-based biosensor system for miRNA detection.

Target miRNA	Biosensor Type	Biosensor Design	LOD	Lineer Range	Sample Type	Ref.
Let-7a	Colorimetric	Fe <sub>3</sub> O <sub>4</sub> nanosheet//H1/H2/miRNA/TMB/H <sub>2</sub> O <sub>2</sub>	13 aM	0.05 fM-12 nM	Serum	[174]
miR-21	Colorimetric	Plate/streptavidin/biotinylated universal translator/miR-21/biotinylated H <sub>2</sub> + GMNP-H1-GMNP-H3/DNA concatemers/ Hemin/H <sub>2</sub> O <sub>2</sub> /ABTS	1 aM	1 aM-7.5 pM	Serum	[173]
miRNA -155	Colorimetric	Au-Fe <sub>3</sub> O <sub>4</sub> /substrate strands/DNAzyme strand/miRNA-155/Mn <sup>2+</sup> /magnetic seperation /AuNP/NaCl	16.7 fM	0.05–1 pM	Serum	[175]
miRNA -141	Fluorescence	MNPs@PDA/FAM-labeled DNA	0.42 pM	5 pM to 5 nM	Cell line	[176]
miR-21	Fluorescence	SA-MNPs/biotin-Probe1/Probe2/Probe3/probe 4/miRNA-21 /ssDNA-FQ probe/Cas12a/crRNA	0.89 fM	10 to 1 × 10 <sup>5</sup> fM	Plasma	[180]
miRNA -141	Fluorescence	MNP/Probe1/Probe2/Probe3/ miRNA-141/ Biotin-Probe4/ SA-HRP/Tyramine/H <sub>2</sub> O <sub>2</sub>	10 fM	10 <sup>2</sup> -10 <sup>6</sup> fM	Plasma	[179]
miRNA -150	Fluorescence	MNP/FAM-labeled- SeqA/ FAM-labeled SeqB/SeqC-BHQ1 /miRNA-150	38 fM	100 fM to 10 nM	Serum	[177]
miRNA -20a	Fluorescence	Fe <sub>3</sub> O <sub>4</sub> @C/ H <sub>3</sub> sequence/ H <sub>2</sub> sequence/ H1 sequence/	0.491 pM	0.450–190 pM	Cell lines	[178]

		miRNA/FAM-labelled FH3N sequence				
miRNA-210	Electrochemiluminescence	MGCE/Fe <sub>3</sub> O <sub>4</sub> NP@SiO <sub>2</sub> -cholesterol-attached hairpin aptamer/TNBC serum sample/MoS <sub>2</sub> naosheet-DNA probe	0.3 fM	1 fM to 100 pM	Serum	[183]
miRNA 155 and miRNA-126	Electrochemiluminescence	Paper/AuNP S1/MCH/Fe <sub>3</sub> O <sub>4</sub> -S2-H1-H2-CdTeQD/K <sub>2</sub> S <sub>2</sub> O <sub>8</sub> DNA2/MEA/ST-Au@g-C <sub>3</sub> N <sub>4</sub> NS/ K <sub>2</sub> S <sub>2</sub> O <sub>8</sub>	5.7 fM for miRNA-155 and 4.2 fM for miRNA-126	$1.0 \times 10^{-14}$ to $1.0 \times 10^{-7}$ M		[182]
miRNA-141	Electrochemiluminescence	GCE/Fe <sub>3</sub> O <sub>4</sub> @SiO <sub>2</sub> @Au-cDNA/miRNA-141/[Ru(dcbpy) <sub>3</sub> ]- Zn(NO <sub>3</sub> ) <sub>2</sub> -sDNA	0.3 fM	0.001–10 pM	Serum	[184]
miRNA-122	SERS	AuAg polyhedral/ S4/ZnO@S1/S2/ target miRNA/ CoFe <sub>2</sub> O <sub>4</sub> @S3/ S5/DNA enzyme/DOX	6.82 aM	10 aM to 10 pM	Serum	[186]
miRNA-122 miRNA-223 miRNA-21	SERS	Serum Sample/Magnetic capture unit (Fe <sub>3</sub> O <sub>4</sub> @Ag-COOH-Capture DNA probes)/SERS-Tag (AuNP-DNA-reporter-Probe DNA)	349 aM for miRNA-122; 374 aM for miRNA-223; 311 aM for miRNA-21	1 fM to 10 nM	Serum	[187]
miRNA-141	SERS	SA@GNPs-reporter probe/miRNA-141/Au@MNPs-Capture probe	1.8 pM	1.8 nM to 1.8 pM	Serum	[189]
miR-141, miR-429 and miR-200b	SERS	SA@GNPs-reporter probe/miRNA-141/Au@MNPs-Capture probe	120 fM	0.2 fM to 1 pM.	Serum	[188]
Let-7b	Optomagnetic	ST-MPs/Biotinylated-RCA template/MNP/target-miRNA	1 fM	10 fM to 1 nM	Cell extract and serum	[192]
Let-7b	Optomagnetic	Streptavidin coated-MNP/substrate sequences/DZb/DZa/Sample	6 pM	10 pM and 100 nM	Serum	[191]

miRNA 21 and miRNA 155	Electrochemical	SPCE/Gold Stir-bar/Fe <sub>3</sub> O <sub>4</sub> @Au@electrochemical tag labeled DNAs /complementary DNA chains/ miRNA-21 and miRNA-155	1.5 fM for miRNA 21 and 1.8 fM for miRNA 155	5 fM – 2nM for miRNA 21 and miRNA 155	Serum	[197]
miR-21	Electrochemical	Gold microelectrode/Au@MNPs/methylene blue redox-labelled probe DNA/ complemenraty DNA/miRNA-21	10 aM	10 aM to 1 nM	Whole blood of nude mice	[198]
miRNA -106a	Electrochemical	GCE/Nafion/Tionine/AF-MNps/LNA/miR-106a/DSN/sDNA/SA-AuNP/biotin-HRP	0.8 fM	1 fM to 5 µM	Serum	[202]
miR-21	Electrochemical	SPCE/GO-IO hybrid/miRNA-21	1.0 fM	1.0 fM to 1 nM	Cell lines	[195]
miRNA -106a and let-7a	Electrochemical	SPCE/PTh/rGO/streptavidin/ biotin-capture probes/[Fe <sub>3</sub> O <sub>4</sub> /TMC/ Au/streptavidin/ biotin-miRNA-106a signal probe/miRNA-106a] and [Fe <sub>3</sub> O <sub>4</sub> /TMC/CdSe@CdS/streptavidin e/ biotin-let-7a signal probe/let-7a]	0.02 fM and for let-7a; 0.06 fM for miR-106a		Plasma	[196]
miRNA -21	Electrochemical	GCE/AuNP/H1/H2-Target/Fe <sub>3</sub> O <sub>4</sub> /CeO <sub>2</sub> @Au-S1/MB	0.33 fM	1 fM to 1 nM	Serum	[200]
	Electrochemical	Gold electrode/probe B/[Fe <sub>3</sub> O <sub>4</sub> @Au/Probe A/miRNA/DSN] /Probe C and D/ NEase	3 × 10 <sup>-18</sup> M	10 <sup>-17</sup> to 10 <sup>-14</sup> M		[199]
miRNA -21	Electrochemical	GCE/rGO/β-CD/MB/[Fe <sub>3</sub> O <sub>4</sub> /DNA/2Fc-DNA/A-1/A-2/miRNA-21]	1.8 fM	10 fM–0.1 nM	Serum	[201]

TMB: 3,3',5,5'-tetramethylbenzidine; GMNP: gold decorated magnetic nanoparticle; ABTS: 2, 2'-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid); PDA: poly- dopamine, FAM: 6-carboxy fluorescence; SA-HRP: streptavidin- horseradish peroxidase; SA-MNPs: Streptavidin-modified MNPs; SeqA: free chain; SeqB: fixed chain; SeqC: auxiliary chain; pDNA:probe DNA; CDs: carbon dots; MGCE: magnetic glassy carbon electrodes; TNBC: triple-negative breast cancer; MCH: 6-Mercapto-1-hexanol (MCH); MEA: monoethanolamine; AuNP: gold nanoparticle; DOX: Raman-probe; SA@GNP: silica-coated Raman-scatter tagged gold NP; ST-MPs: streptavidin-coated magnetic particle; RCA: rolling circle amplification; SPCE: screen printed carbon electrode; LNA: hairpin locked nucleic acid probes; DSN: duplex-specific nuclease; biotin-HRP: biotin-labeled horseradish peroxidase; AF-MNps: aldehyde-functionalized MNps (Fe<sub>3</sub>O<sub>4</sub> nanoparticle); GO-IO hybrid: graphene oxide-loaded iron oxide; PTh: Polythiophene; rGO: reduced graphene oxide; TMC: trimethylchitosan; GCE: glassy carbon electrode; MB:methylene blue; β-CD: β-cyclodextrin; 2Fc-DNA: double ferrocene-labeled hairpin DNA