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Graphene oxide and threose nucleic acid (TNA) -functionalized platform (GTP) for rapid microRNA detection

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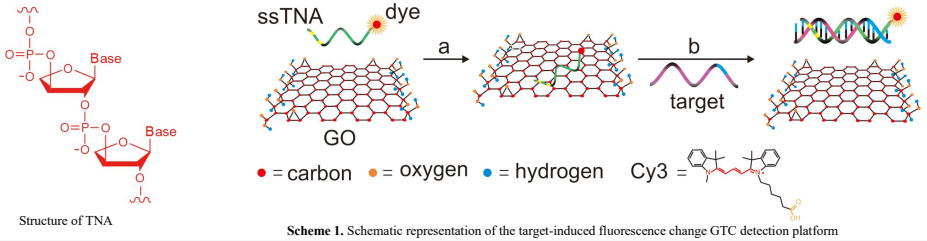
Introduction

MicroRNAs (miRNAs), a class of non-coding RNAs, are involved in many crucial biological processes, which have emerged as a new set of biomarkers for disease diagnosis and treatment. Low sensitivity and detection complexity of traditional analytical methods for miRNA seriously limit its practical applications, especially intracellular or in vivo. In this case, exploring amplification strategies that can rapidly and accurately detect the concentration of miRNA intracellular or in vivo are urgently needed. Herein, we fabricate a nanocomposite platform (GTP) composed of graphene oxide (GO) and a fluorophore-labeled threose nucleic acid (TNA) strand for rapid miRNA 155 detection. Cy3 fluorescence of TNA will be quenched by GO without the presence of miRNA. Once in the presence of target miRNA, TNA-Cy3 adsorbed on GO will be released to form duplex with the miRNA. Finally, the fluorescence of Cy3 will resume and give a "turn-on" signal. The lowest detection limit of our designed nanocomposite can be down to 33 pM, which is more sensitive than the other detection platforms. Moreover, our nanocomposite can efficiently detect miRNA 155 in MCF-7, MDA-MB-468 and BT-549 cancer cells. Overall, our TNA-based detection platform is highly specific and selective toward target miRNA with high nuclease and thermal stabilities. Our work illuminated for using TNA as a component to construct a biocompatible platform for microRNA detection that offers an ideal strategy for diagnosis and treatment of miRNA-related diseases.

Working mechanism of the GTP platform



Structure of TNA

Scheme 1. Schematic representation of the target-induced fluorescence change GTC detection platform

Sensitivity and specificity of the GTP

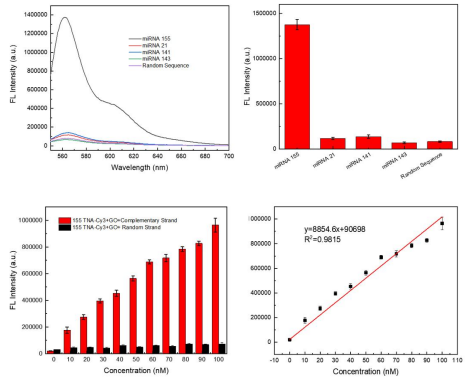


Figure 1. The selectivity of GTP hybridizes to different miRNA sequences: target miR-155, random sequence RNA, miR-21, miR-141, miR-143.

MiRNA imaging in live cells

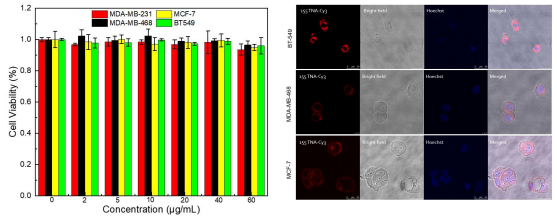


Figure 2. Cytotoxicity of GTP and confocal fluorescence images of BT-549, MDA-MB-468 and MCF-7 cells incubated with GTC detection platform.

Conclusion

GTP obtained the following properties:
(1) High detection sensitivity and specificity of target miRNAs;
(2) High stability in a complex physiological environment;
(3) Accurate discrimination for different miRNAs without cross-reaction;
(4) Accurate detection and monitoring of miRNA in cells.

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