Supporting Information For

Molecular logic gates based on a DNA tweezers responsive to multiplex restriction endonucleases

Xiao-Yu Li,[a] Juan Huang,[a] Hong-Xin Jiang,[a] Yi-Chen Du,[a] Gui-Mei Han,[a] De-Ming Kong[abc]*

[a] *State Key Laboratory of Medicinal Chemical Biology, College of Chemistry, Nankai University, Tianjin 300071, People's Republic of China.*

[b] *Collaborative Innovation Center of Chemical Science and Engineering (Tianjin), Tianjin 300071, People's Republic of China.*

[c] *Tianjin Key Laboratory of Biosensing and Molecular Recognition, Research Centre for Analytical Sciences, Nankai University, Tianjin, 300071, People's Republic of China*

** Corresponding author. Tel.: +86-22-23500938; Fax: +86-22-23502458*

E-mail address: kongdem@nankai.edu.cn (D.-M. Kong).

1. The DNA oligonucleotides used in this work

Table S1. The oligonucleotides used in this work

DNA strands	Sequence (5′→3′)
A	FAM-TGC GGC CGC AGA GTG ACC ATC AAC CTG GAA TGA GGA TCC T-BHQ-2 FAM = 6-Carboxyfluorescein BHQ-2 = Black Hole Quencher
B	GGT CAC TCT GCG GCC GCA CGA ATT CCA TAC ACG GTC TAT GCG
C	GGA GTC CTA CTG TCT GCA AGC TTC AGG ATC CTC ATT CCA GGT
D	CGC ATA GAC CGT GTA TGG AAT TCG GAA GCT TGC AGA CAG TAG GAC TCC

2. Fluorescence responses of the closed tweezers to restriction endonucleases

2.1 Fluorescence responses of the closed tweezers to BamH I

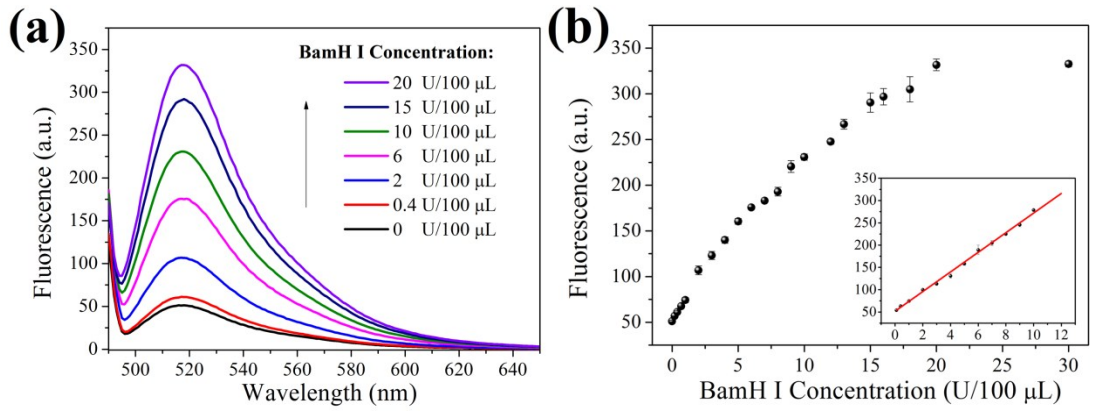


Fig. S1 (a) Fluorescence spectra of the closed tweezers in the presence of different concentrations of BamH I. (b) The fluorescence change at 517 nm as function of BamH I concentration. The inset shows the fluorescence change in the BamH I concentration range of 0–10 U/100 μL. The solid line represents a linear fit to the data.

2.2 Fluorescence responses of the closed tweezers to Hind III

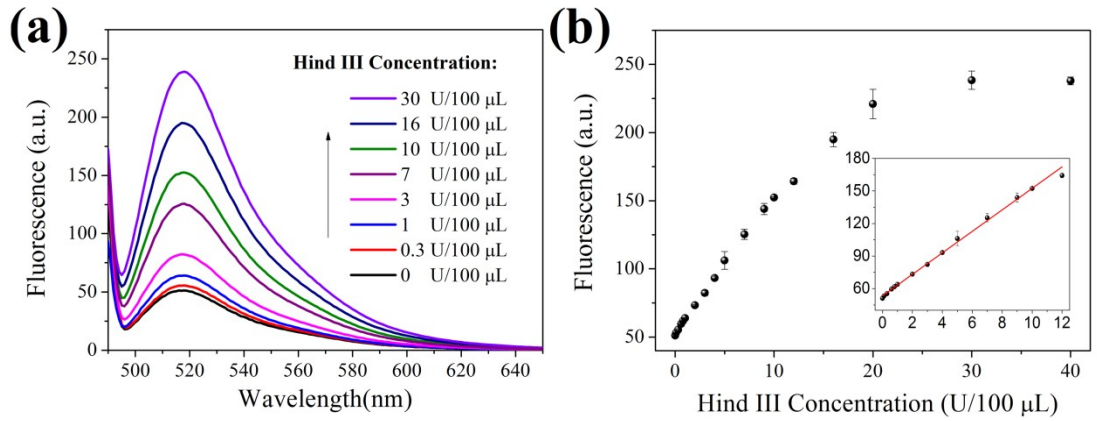


Fig. S2 (a) Fluorescence spectra of the closed tweezers in the presence of different concentrations of Hind III. (b) The fluorescence change at 517 nm as function of Hind III concentration. The inset shows the fluorescence change in the Hind III concentration range of 0–12 U/100 μL. The solid line represents a linear fit to the data.

2.3 Fluorescence responses of the closed tweezers to Not I

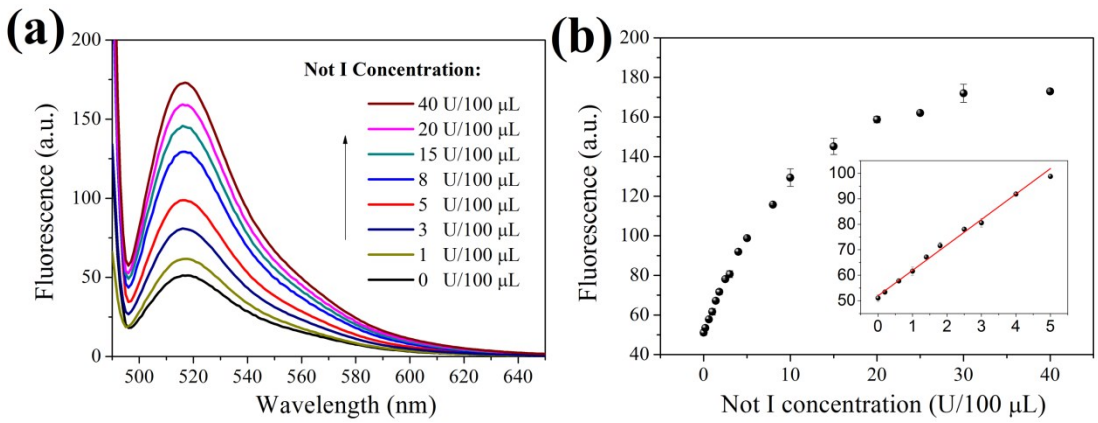


Fig. S3 (a) Fluorescence spectra of the closed tweezers in the presence of different concentrations of Not I. (b) The fluorescence change at 517 nm as function of Not I concentration. The inset shows the fluorescence change in the Not I concentration range of 0–5 U/100 μL. The solid line represents a linear fit to the data.

3. One-input YES logic gates

3.1 One-input YES logic gate using BamH I as input

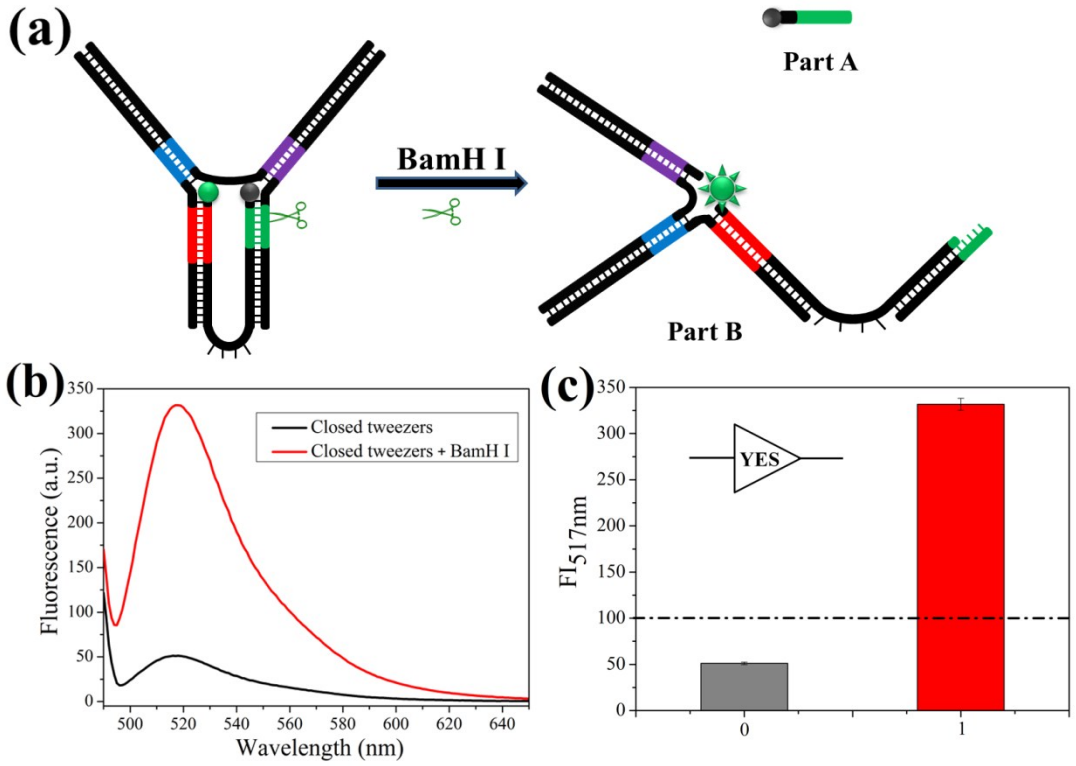


Fig. S4 (a) Principle of the YES logic gate using BamH I as input. (b) Fluorescence spectra of the closed tweezers before and after addition of BamH I (0.2 U/μL). (c) The outputs of the YES logic gate.

3.2 One-input YES logic gate using Hind III as input

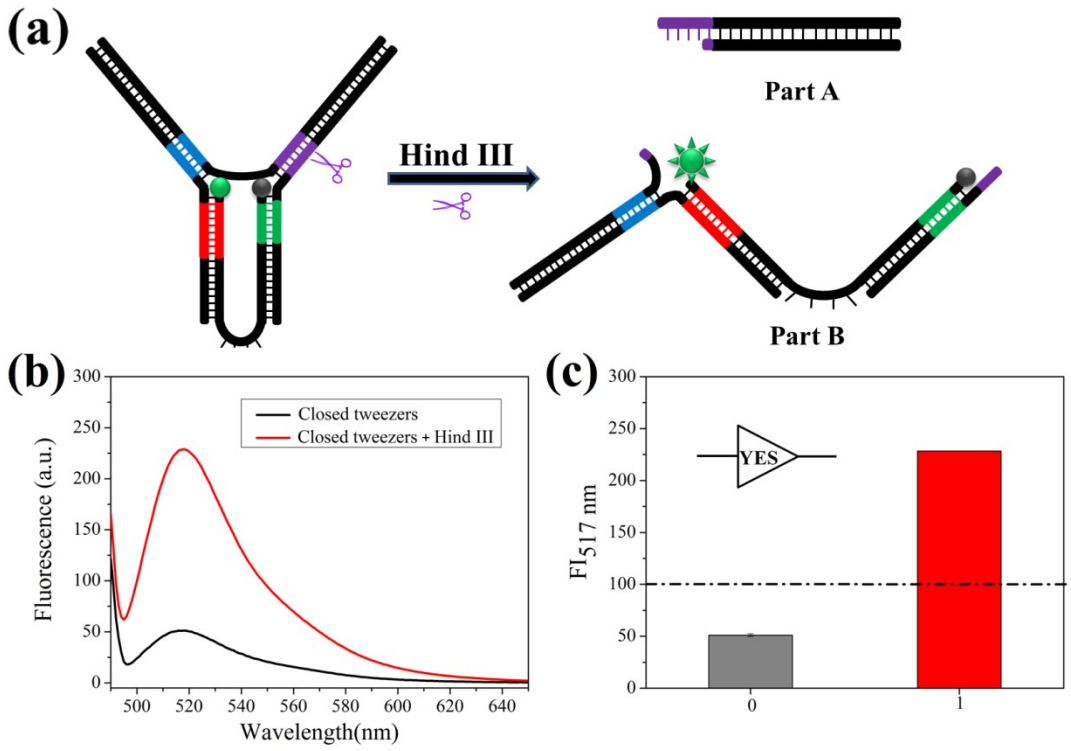


Fig. S5 (a) Principle of the YES logic gate using Hind III as input. (b) Fluorescence spectra of the closed tweezers before and after addition of Hind III (0.3 U/μL). (c) The outputs of the YES logic gate.

3.3 One-input YES logic gate using Not I as input

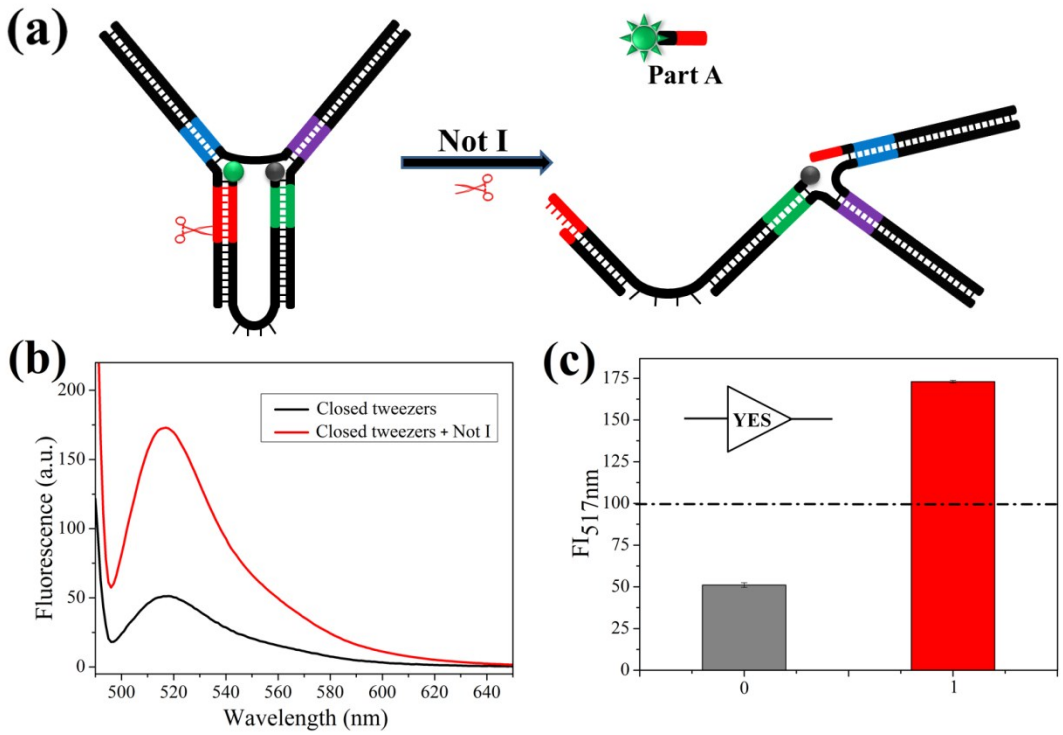
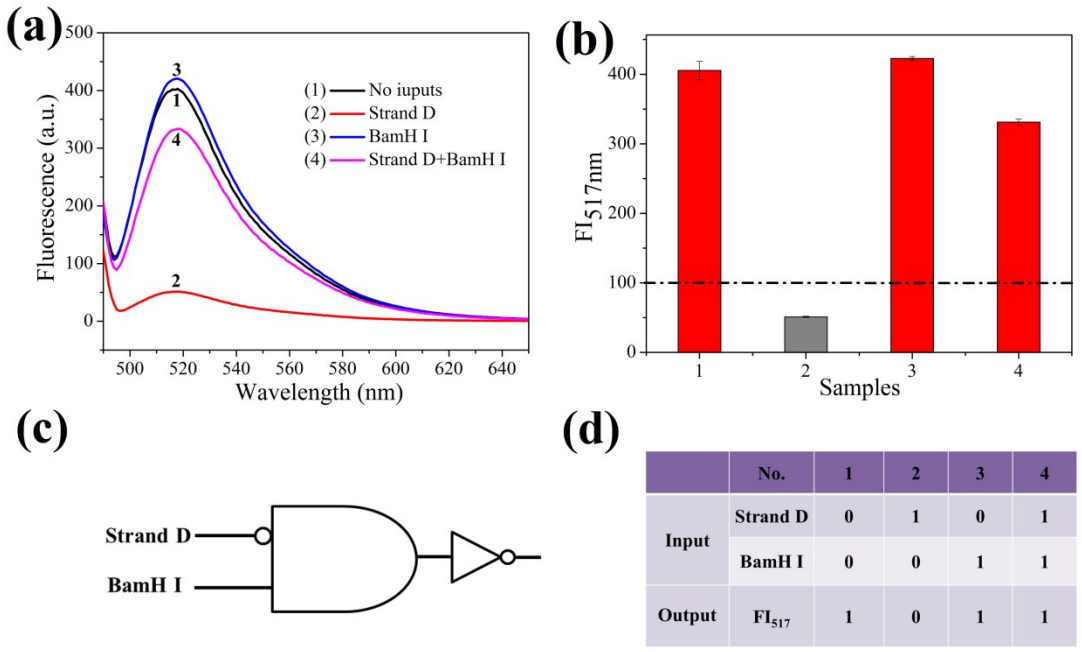


Fig. S6 (a) Principle of the YES logic gate using Not I as input. (b) Fluorescence spectra of the closed tweezers before and after addition of Not I (0.4 U/μL). (c) The outputs of the YES logic gate.

4. Two-input IMPLICATION logic gates

4.1 Two-input IMPLICATION logic gate using Strand D and BamH I as inputs

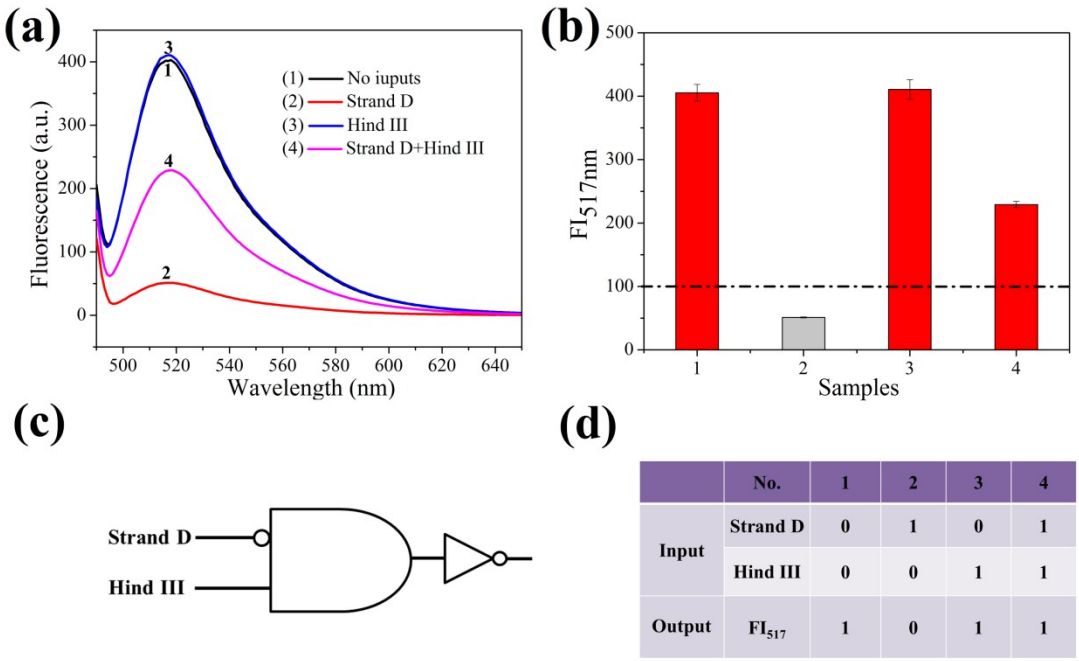


	No.	1	2	3	4
Input	Strand D	0	1	0	1
	BamH I	0	0	1	1
Output	FI_{517}	1	0	1	1

Fig. S7 Two-input DNA IMPLICATION logic gate system using Strand **D** and BamH I as inputs. (a) Fluorescence spectra of the closed tweezers in the presence of different inputs. [Strand **D**] = 100 nM; [BamH I] = 0.20 U/μL. (b) Fluorescence intensity of the closed tweezers at 517 nm in the presence of different inputs. (c) Scheme of the IMPLICATION logic gate. (d) Truth table of the IMPLICATION logic gate.

4.2 Two-input IMPLICATION logic gate using Strand D and

Hind III as inputs

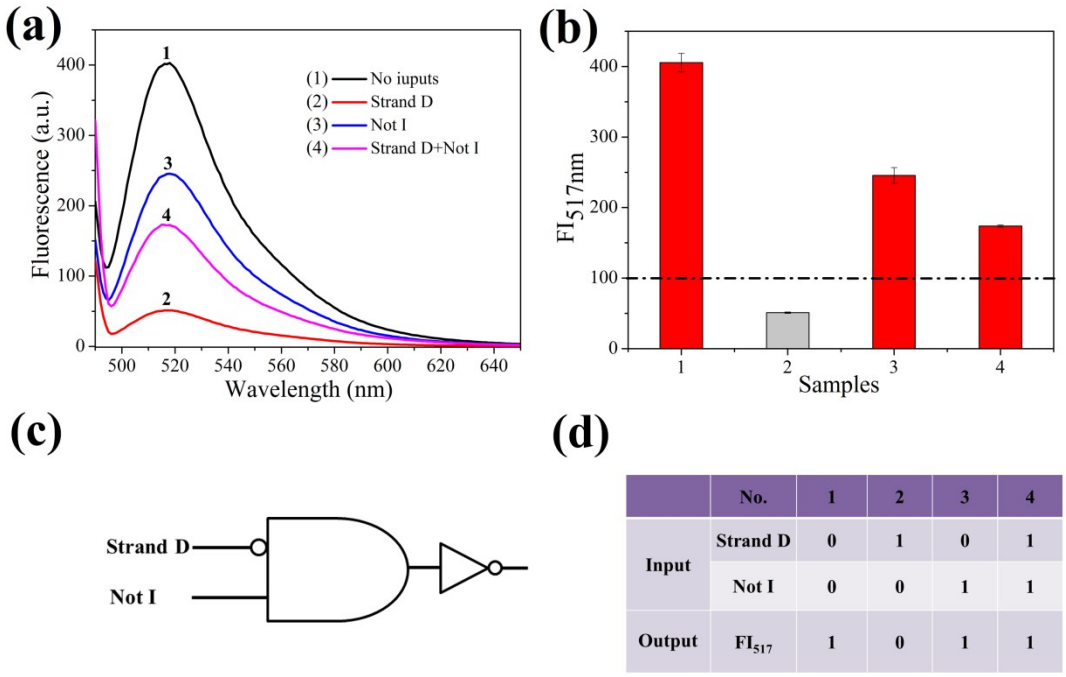


	No.	1	2	3	4
Input	Strand D	0	1	0	1
	Hind III	0	0	1	1
Output	FI_{517}	1	0	1	1

Fig. S8 Two-input DNA IMPLICATION logic gate system using Strand **D** and Hind III as inputs. (a) Fluorescence spectra of the closed tweezers in the presence of different inputs. [Strand **D**] = 100 nM; [Hind III] = 0.30 U/μL. (b) Fluorescence intensity of the closed tweezers at 517 nm in the presence of different inputs. (c) Scheme of the IMPLICATION logic gate. (d) Truth table of the IMPLICATION logic gate.

4.3 Two-input IMPLICATION logic gate using Strand D and

Not I as inputs

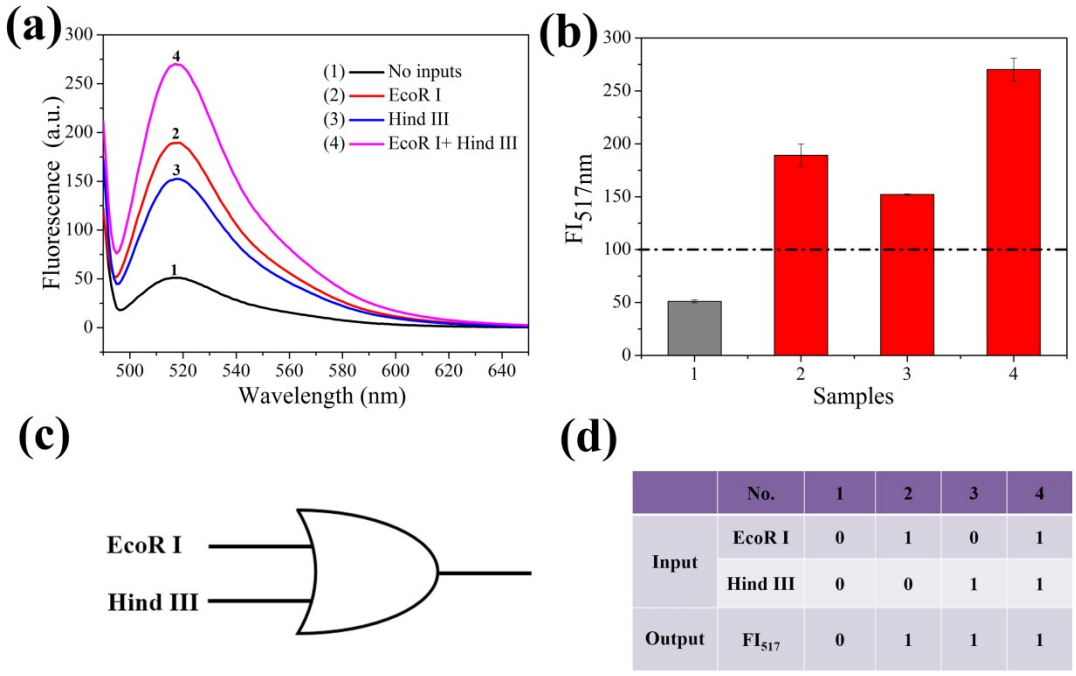


	No.	1	2	3	4
Input	Strand D	0	1	0	1
	Not I	0	0	1	1
Output	FI_{517}	1	0	1	1

Fig. S9 Two-input DNA IMPLICATION logic gate system using Strand **D** and Not I as inputs. (a) Fluorescence spectra of the closed tweezers in the presence of different inputs. [Strand **D**] = 100 nM; [Not I] = 0.40 U/μL. (b) Fluorescence intensity of the closed tweezers at 517 nm in the presence of different inputs. (c) Scheme of the IMPLICATION logic gate. (d) Truth table of the IMPLICATION logic gate.

5. Two-input OR logic gates

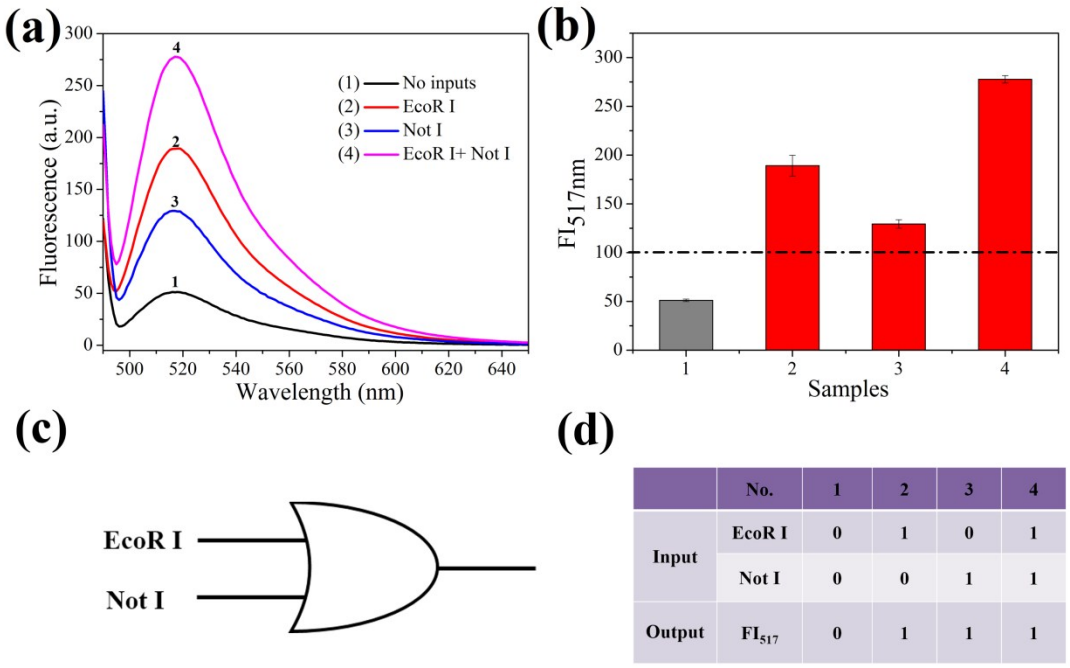
5.1 Two-input OR logic gate using EcoR I and Hind III as inputs



	No.	1	2	3	4
Input	EcoR I	0	1	0	1
	Hind III	0	0	1	1
Output	FI_{517}	0	1	1	1

Fig. S10 Two-input DNA OR logic gate system using EcoR I and Hind III as inputs. (a) Fluorescence spectra of the closed tweezers in the presence of different inputs. [EcoR I] = [Hind III] = 0.06 U/μL. (b) Fluorescence intensity of the closed tweezers at 517 nm in the presence of different inputs. (c) Scheme of the OR logic gate. (d) Truth table of the OR logic gate.

5.2 Two-input OR logic gate using EcoR I and Not I as inputs



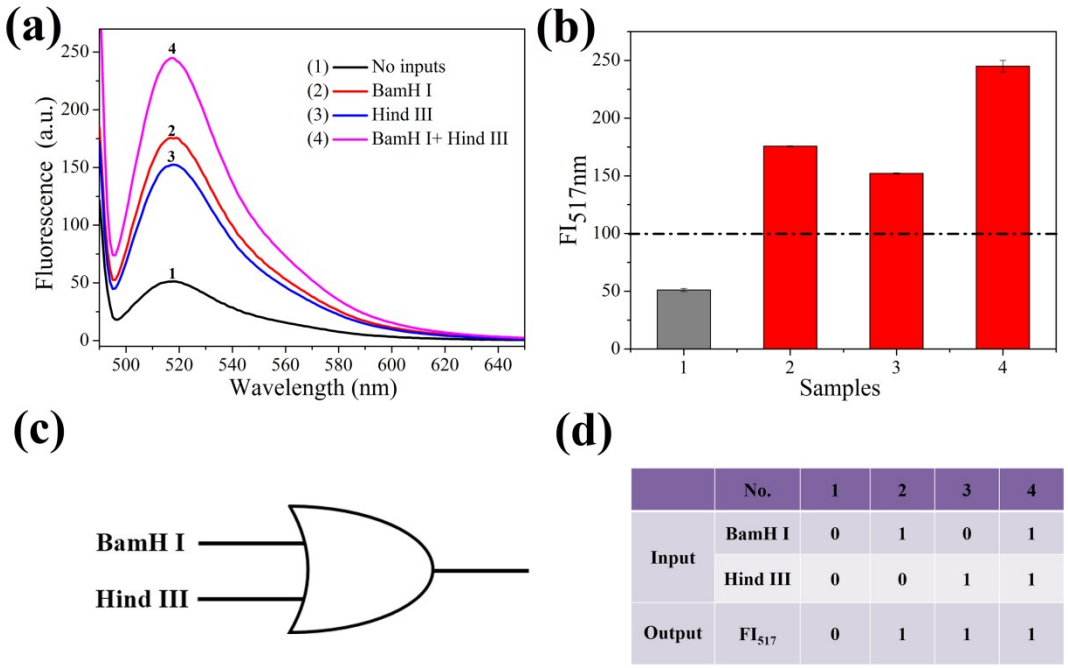
(d)

	No.	1	2	3	4
Input	EcoR I	0	1	0	1
	Not I	0	0	1	1
Output	FI_{517}	0	1	1	1

Fig. S11 Two-input DNA OR logic gate system using EcoR I and Not I as inputs. (a) Fluorescence spectra of the closed tweezers in the presence of different inputs. [EcoR I] = [Not I] = 0.06 U/μL. (b) Fluorescence intensity of the closed tweezers at 517 nm in the presence of different inputs. (c) Scheme of the OR logic gate. (d) Truth table of the OR logic gate.

5.3 Two-input OR logic gate using BamH I and Hind III as

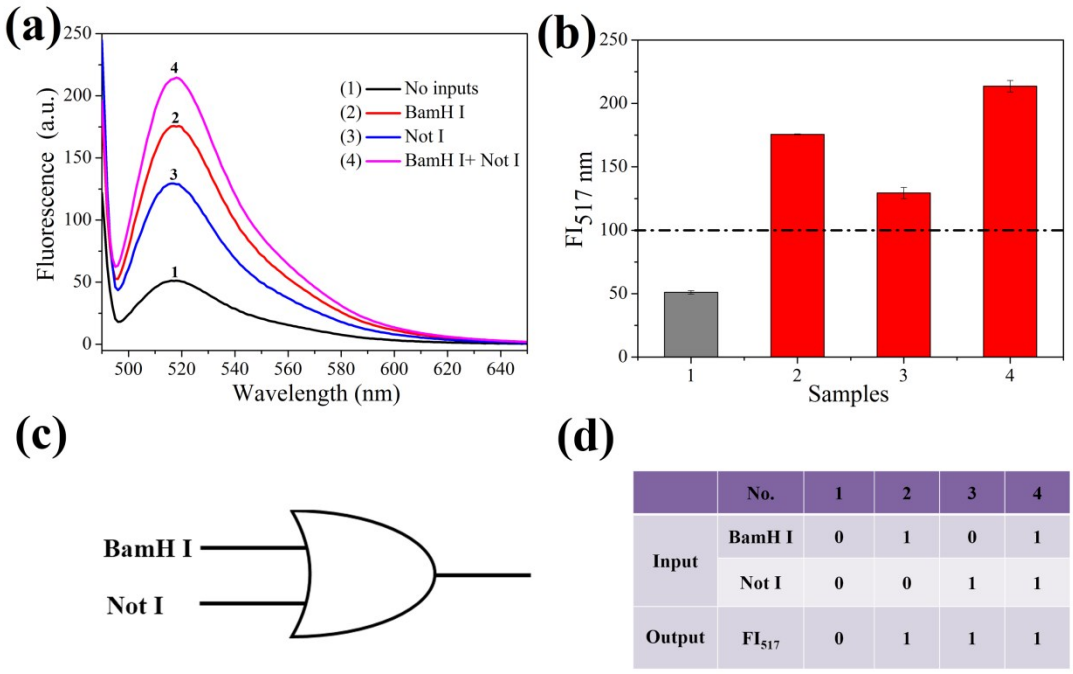
inputs



	No.	1	2	3	4
Input	BamH I	0	1	0	1
	Hind III	0	0	1	1
Output	FI_{517}	0	1	1	1

Fig. S12 Two-input DNA OR logic gate system using BamH I and Hind III as inputs. (a) Fluorescence spectra of the closed tweezers in the presence of different inputs. [BamH I] = [Hind III] = 0.06 U/μL. (b) Fluorescence intensity of the closed tweezers at 517 nm in the presence of different inputs. (c) Scheme of the OR logic gate. (d) Truth table of the OR logic gate.

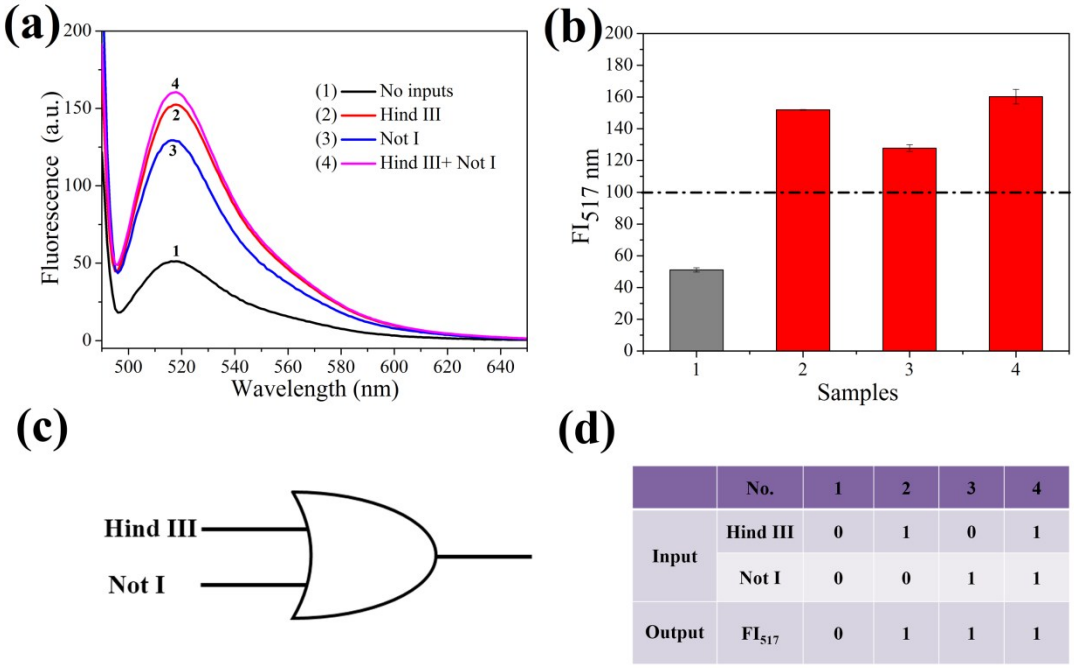
5.4 Two-input OR logic gate using BamH I and Not I as inputs



	No.	1	2	3	4
Input	BamH I	0	1	0	1
	Not I	0	0	1	1
Output	FI_{517}	0	1	1	1

Fig. S13 Two-input DNA OR logic gate system using BamH I and Not I as inputs. (a) Fluorescence spectra of the closed tweezers in the presence of different inputs. [BamH I] = [Not I] = 0.06 U/μL. (b) Fluorescence intensity of the closed tweezers at 517 nm in the presence of different inputs. (c) Scheme of the OR logic gate. (d) Truth table of the OR logic gate.

5.5 Two-input OR logic gate using Hind III and Not I as inputs

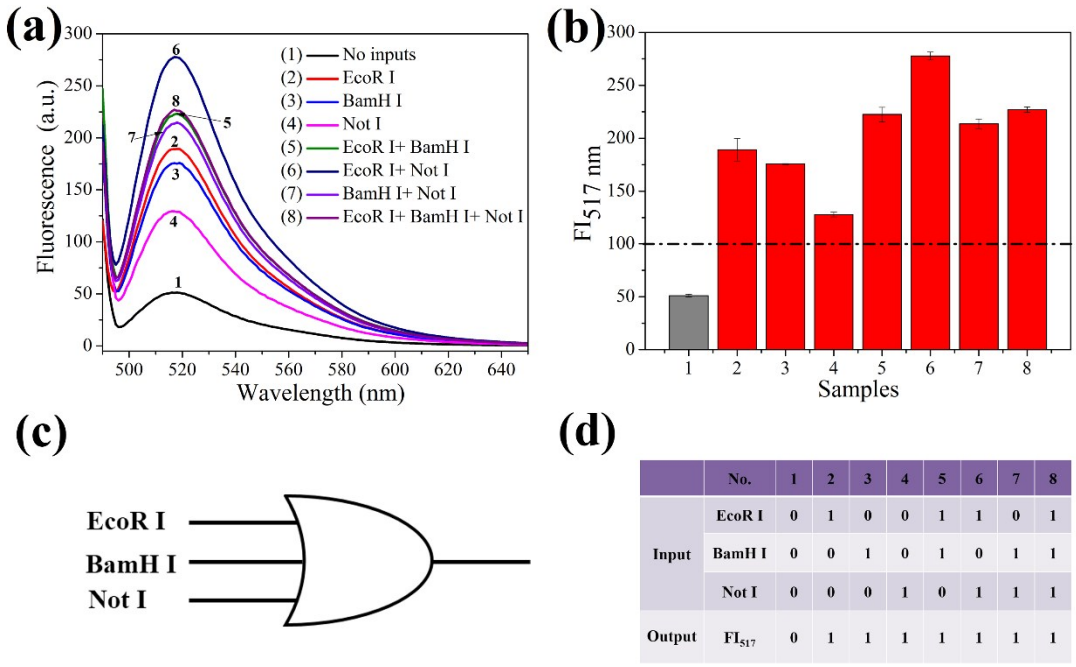


	No.	1	2	3	4
Input	Hind III	0	1	0	1
	Not I	0	0	1	1
Output	FI_{517}	0	1	1	1

Fig. S14 Two-input DNA OR logic gate system using Hind III and Not I as inputs. (a) Fluorescence spectra of the closed tweezers in the presence of different inputs. [Hind III] = [Not I] = 0.06 U/μL. (b) Fluorescence intensity of the closed tweezers at 517 nm in the presence of different inputs. (c) Scheme of the OR logic gate. (d) Truth table of the OR logic gate.

6. Three-input OR logic gates

6.1 Three-input OR logic gate using EcoR I, BamH I and Not I as inputs

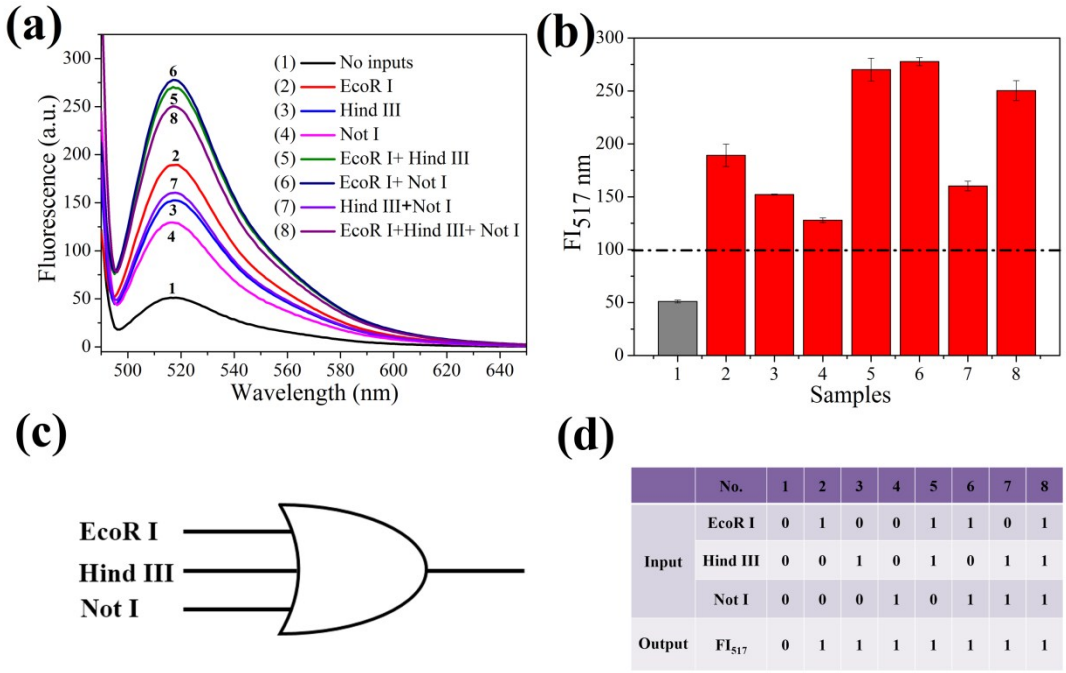


	No.	1	2	3	4	5	6	7	8
Input	EcoR I	0	1	0	0	1	1	0	1
	BamH I	0	0	1	0	1	0	1	1
	Not I	0	0	0	1	0	1	1	1
Output	FI_{517}	0	1	1	1	1	1	1	1

Fig. S15 Three-input DNA OR logic gate system using EcoR I, BamH I and Not I as inputs. (a) Fluorescence spectra of the closed tweezers in the presence of different inputs. [EcoR I] = [BamH I] = [Not I] = 0.06 U/μL. (b) Fluorescence intensity of the closed tweezers at 517 nm in the presence of different inputs. (c) Scheme of the OR logic gate. (d) Truth table of the OR logic gate.

6.2 Three-input OR logic gate using EcoR I, Hind III and Not I

as inputs

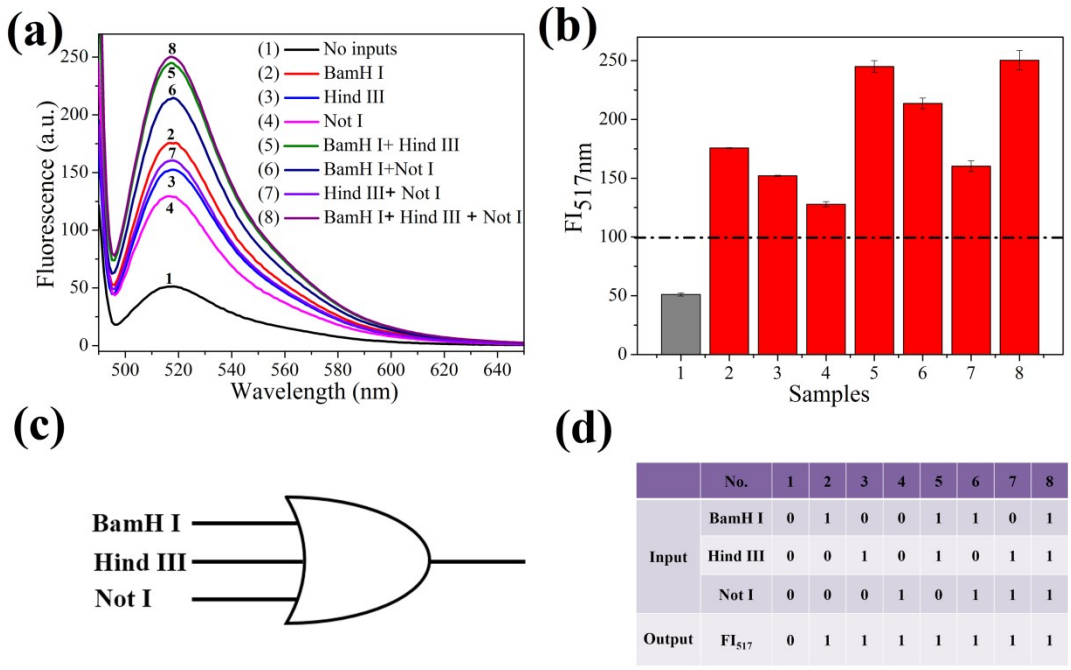


	No.	1	2	3	4	5	6	7	8
Input	EcoR I	0	1	0	0	1	1	0	1
	Hind III	0	0	1	0	1	0	1	1
	Not I	0	0	0	1	0	1	1	1
Output	FI_{517}	0	1	1	1	1	1	1	1

Fig. S16 Three-input DNA OR logic gate system using EcoR I, Hind III and Not I as inputs. (a) Fluorescence spectra of the closed tweezers in the presence of different inputs. [EcoR I] = [Hind III] = [Not I] = 0.06 U/μL. (b) Fluorescence intensity of the closed tweezers at 517 nm in the presence of different inputs. (c) Scheme of the OR logic gate. (d) Truth table of the OR logic gate.

6.3 Three-input OR logic gate using BamH I, Hind III and Not I

as inputs



	No.	1	2	3	4	5	6	7	8
Input	BamH I	0	1	0	0	1	1	0	1
	Hind III	0	0	1	0	1	0	1	1
	Not I	0	0	0	1	0	1	1	1
Output	FI_{517}	0	1	1	1	1	1	1	1

Fig. S17 Three-input DNA OR logic gate system using BamH I, Hind III and Not I as inputs. (a) Fluorescence spectra of the closed tweezers in the presence of different inputs. [BamH I] = [Hind III] = [Not I] = 0.06 U/μL. (b) Fluorescence intensity of the closed tweezers at 517 nm in the presence of different inputs. (c) Scheme of the OR logic gate. (d) Truth table of the OR logic gate.