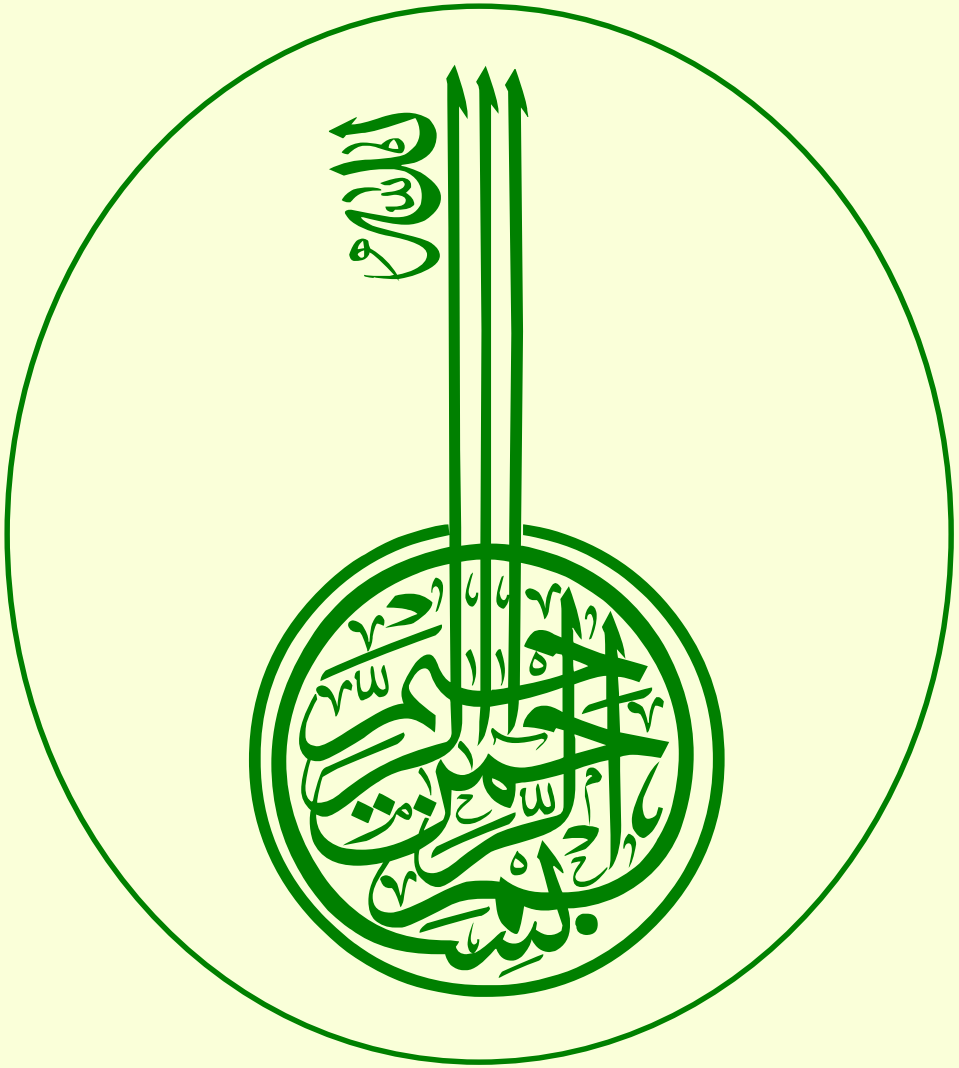

بسم الله الرحمن الرحيم

Study on the stability of DNA triplex nano-assembly

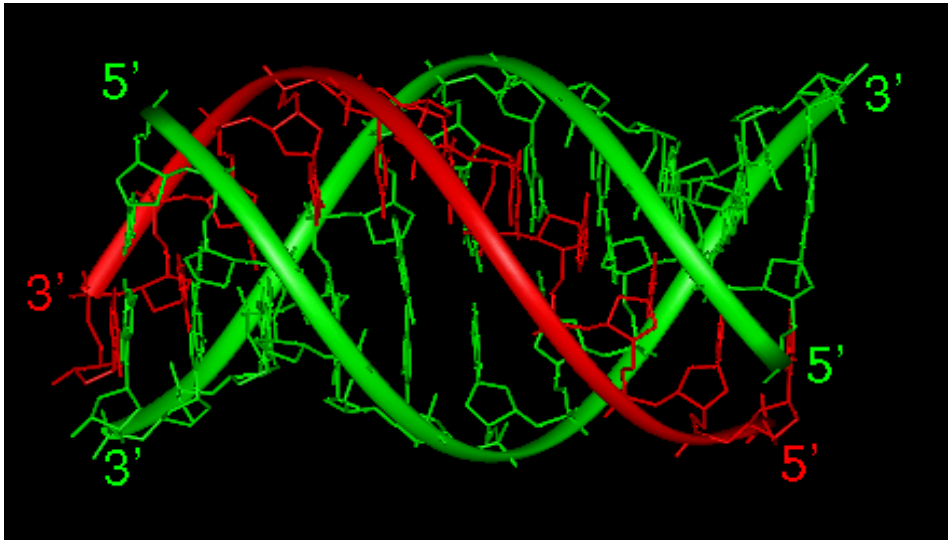
contents

- ***Introduction of DNA triplex***
- ***Investigation of DNA triplex formation***
- ***How the DNA triplex can be stabilized?***
- ***The effect of CNT on the formation of triplex***
- ***The effect of synthetic compounds in the triplex stability***

A DNA triplex is formed when pyrimidine or purine bases occupy the major groove of the DNA double Helix forming Hoogsteen pairs with purines of the Watson-Crick basepairs.

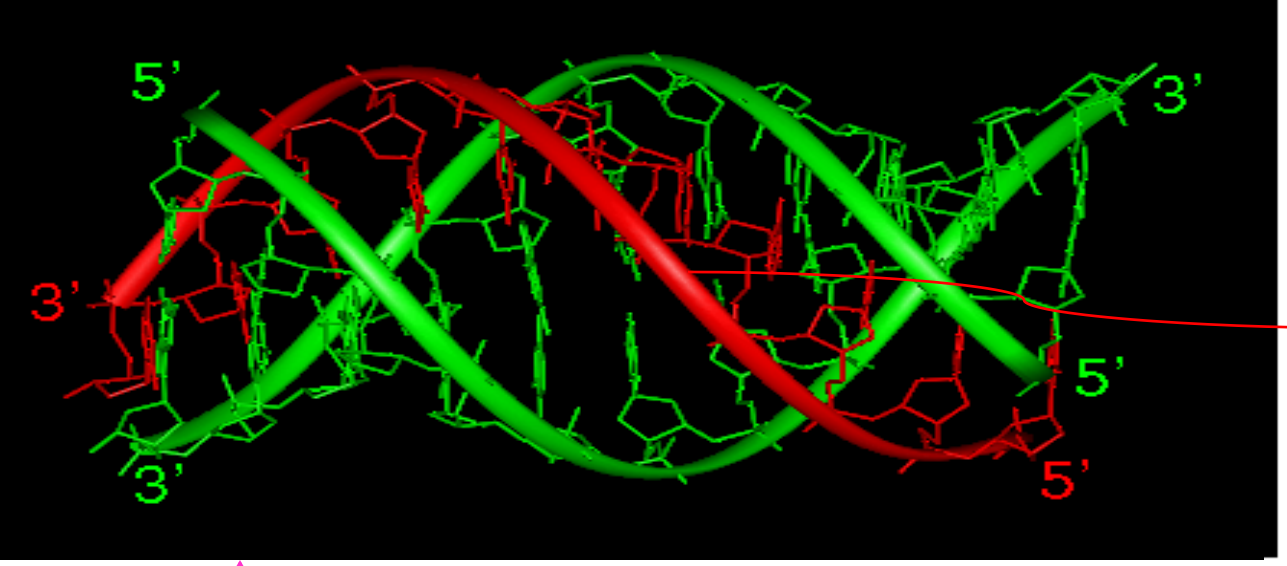
Annu. Rev. Biochem (1995) 64:65-95

Oligonucleotide-directed triple helix formation offers a means to target specific sequences in DNA and interfere with gene expression at the transcriptional level.



The formation of a three-stranded, or triple-helical, nucleic acid structure was first observed in 1957 when Felsenfeld et al demonstrated stable and specific binding of a single-stranded polyuridine oligonucleotide to a polyuridine/polyadenine duplex.

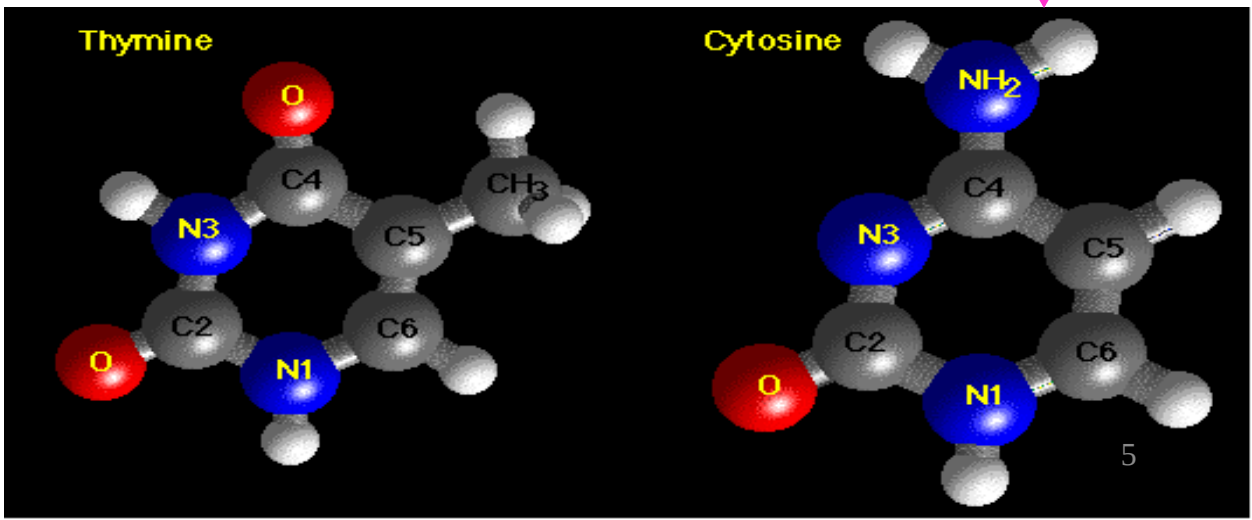
J. Am. Chem. Soc (1957) 79:2023–2024



TFO: Triplex Formation Oligonucleotide

The purine bases

The pyrimidine bases

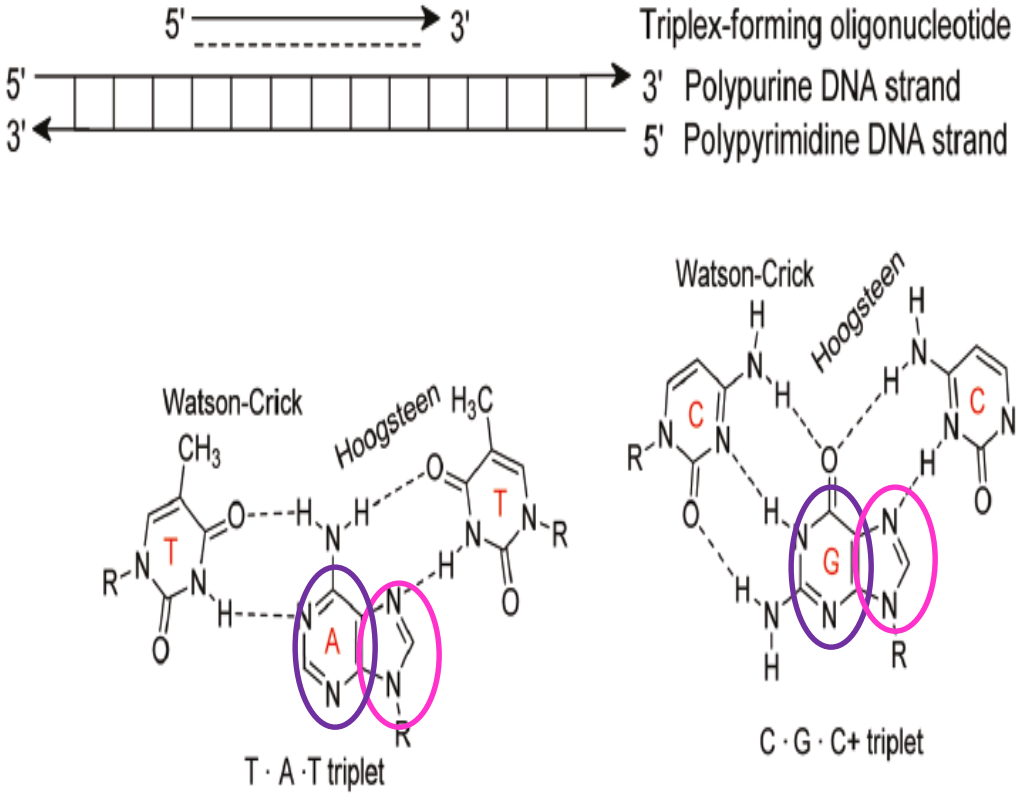


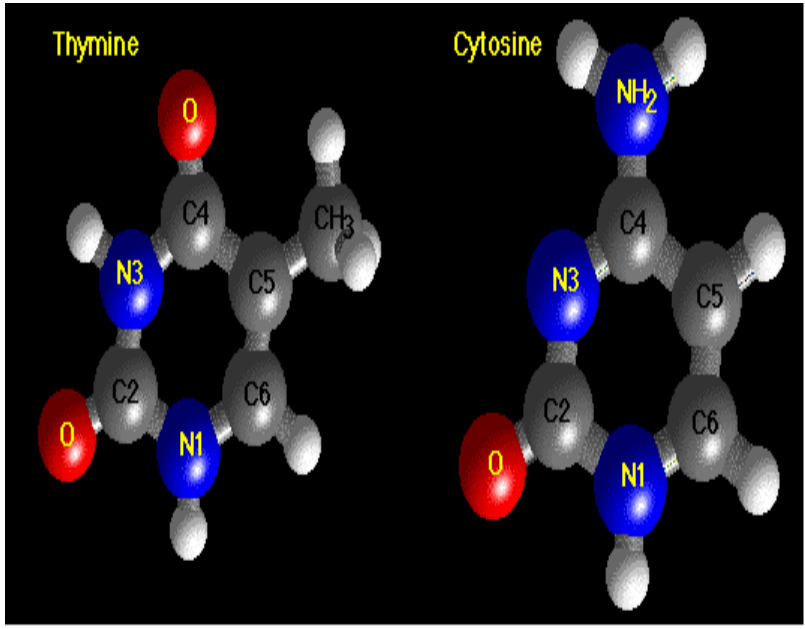
A TFO can be categorized depending on its base composition and binding orientation relative to its DNA target site.

Parallel Orientation

TFO consisting of cytosine (C) and thymine (T) binds parallel to the purine-rich strand of DNA via Hoogsteen bonds. Protonation at N3 of cytosine is required for proper Hoogsteen bonding with N7 of guanine, but this occurs only under acidic conditions.

Biochemistry (1988) 27:9108–9112



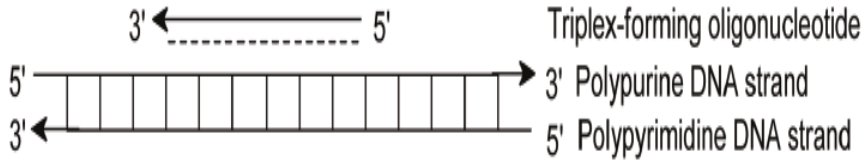


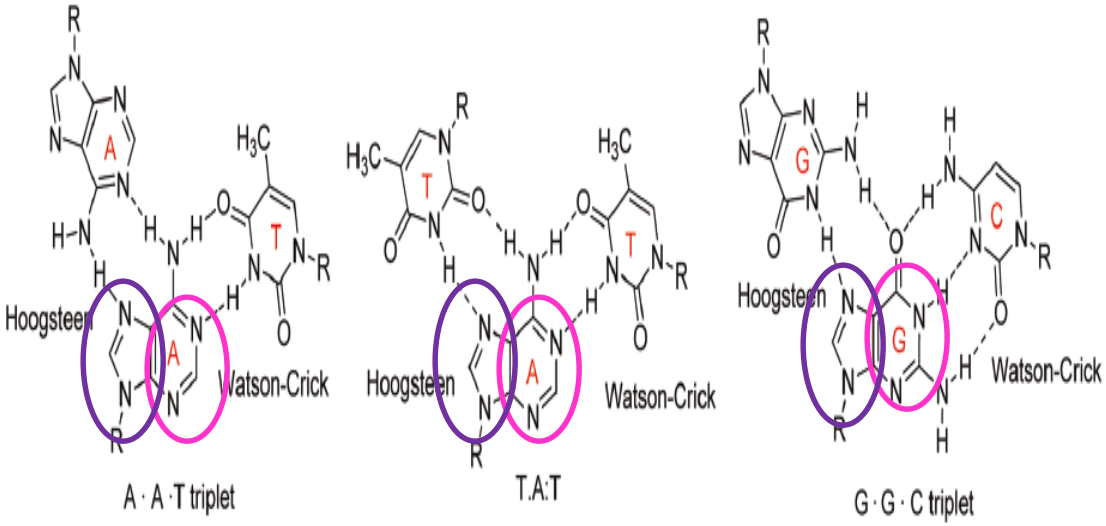
ACCOUNTS OF CHEMICAL RESEARCH (2011) 44: 134–146

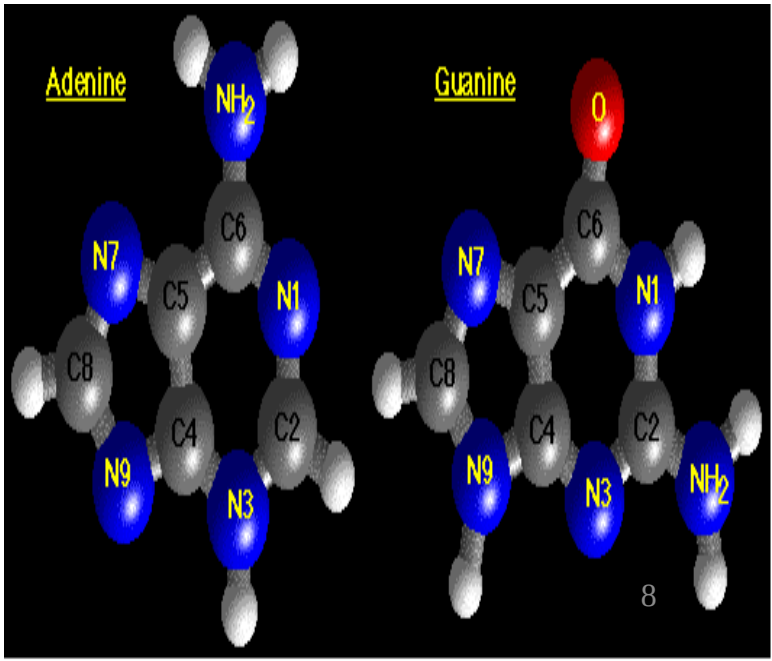
Antiparallel Orientation

TFO consisting of adenine (A), thymine (T), Guanine (G) binds antiparallel to the purine-rich strand in DNA via reverse Hoogsteen bonds and requires no base protonation and exhibits largely pH independent binding.

Proc Natl Acad Sci USA (1991) 88:8227–8231







ACCOUNTS OF CHEMICAL RESEARCH (2011) 44: 134–146

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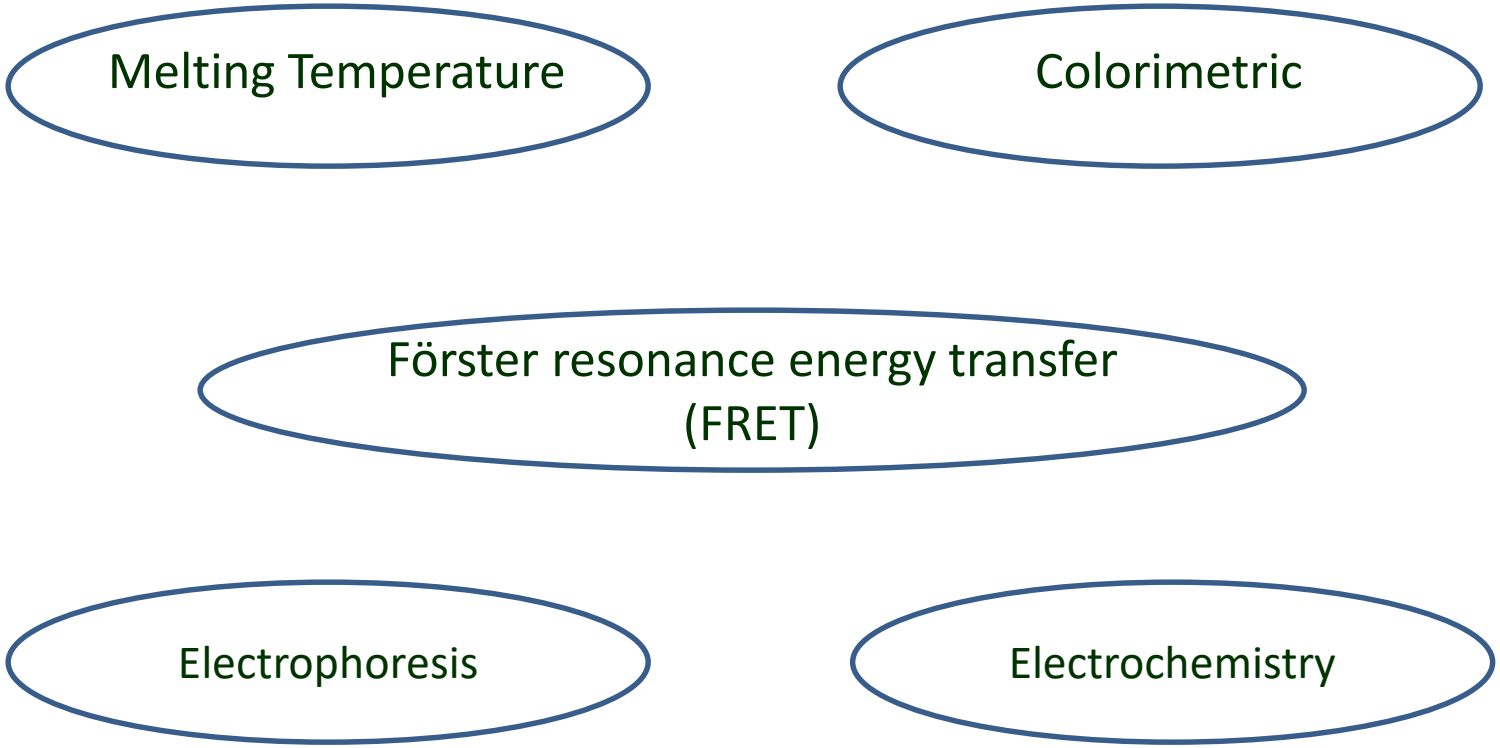
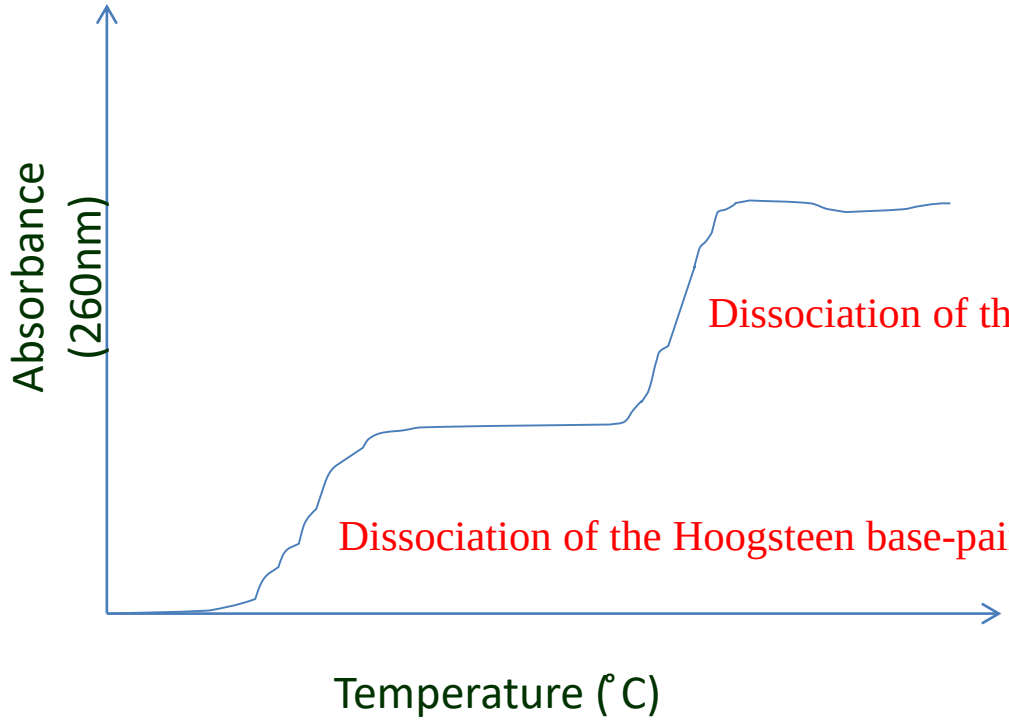
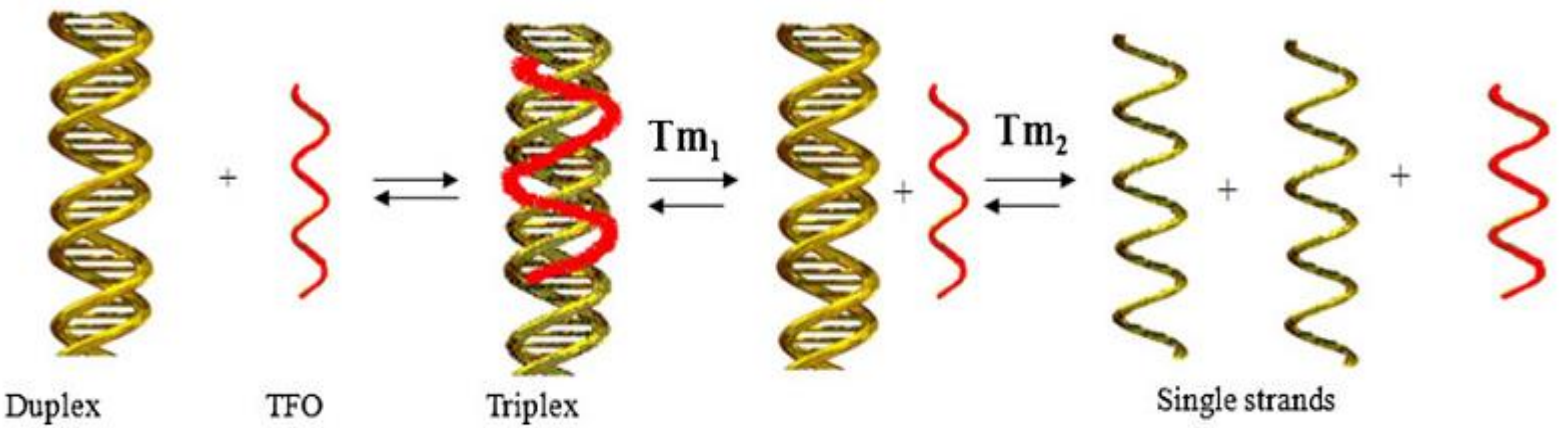
Investigation of DNA triplex formation

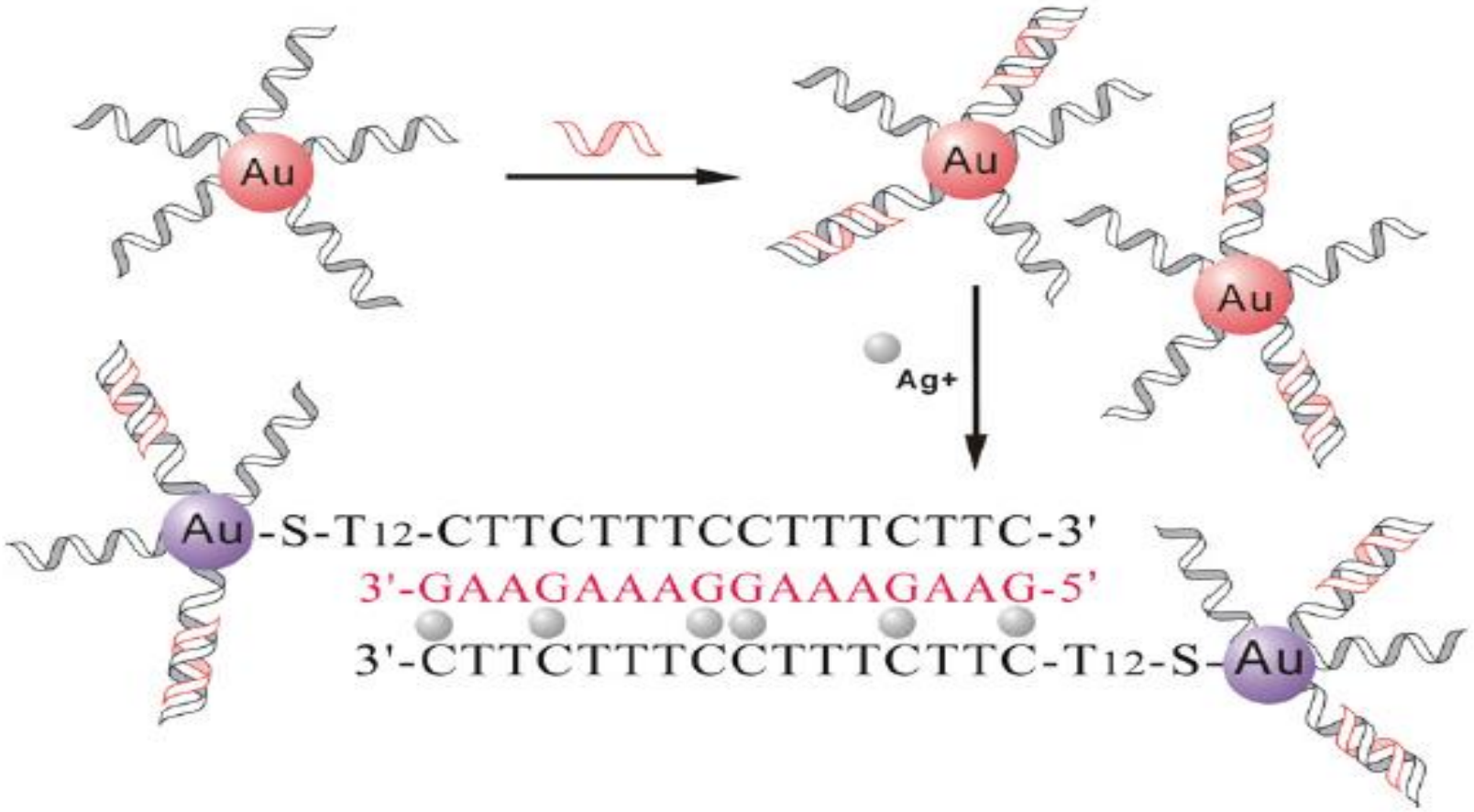


Melting Temperature



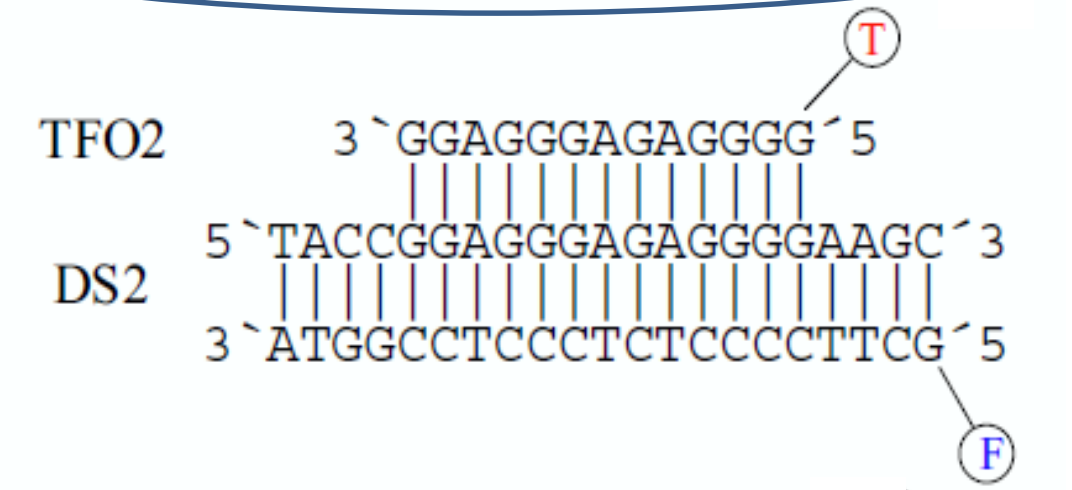


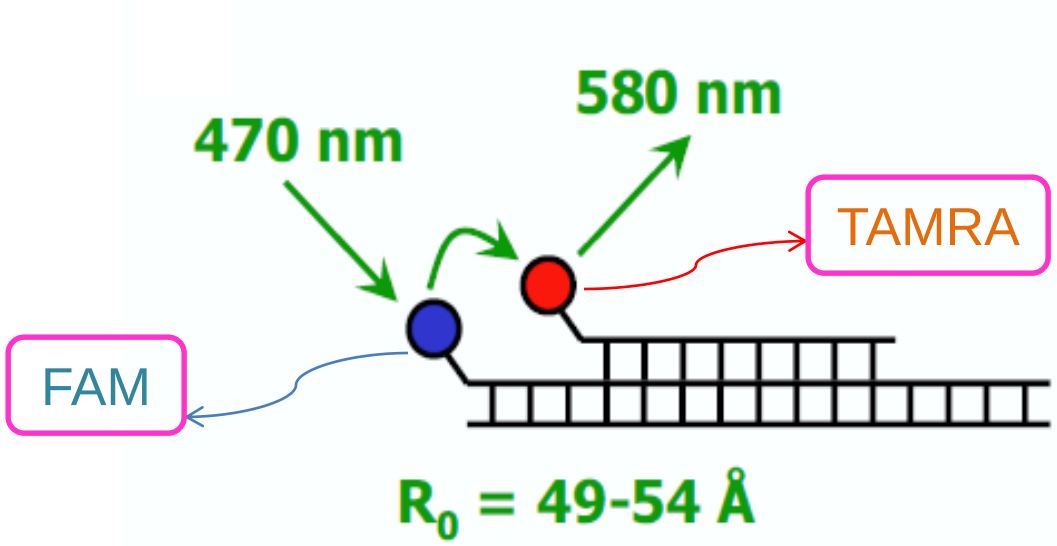
Colorimetric



Spectrochimica Acta Part A (2011) 79:956- 961

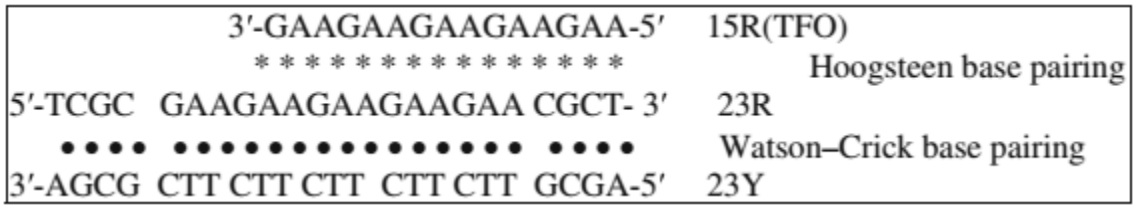
Förster resonance energy transfer (FRET)

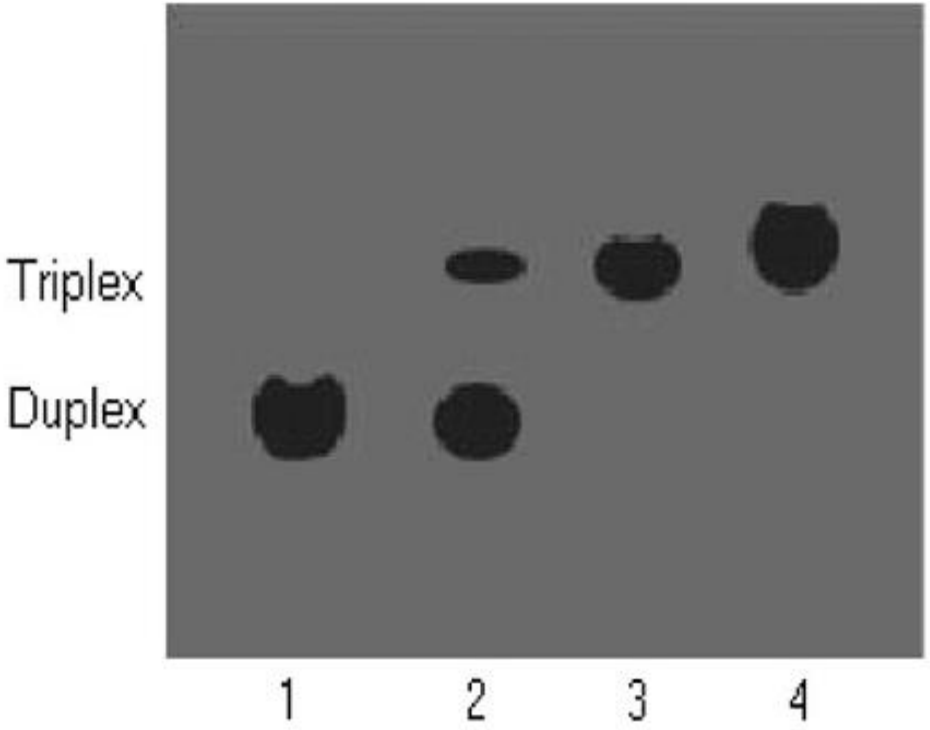




BMC Biochemistry(2002) 3: 1-9

Electrophoresis

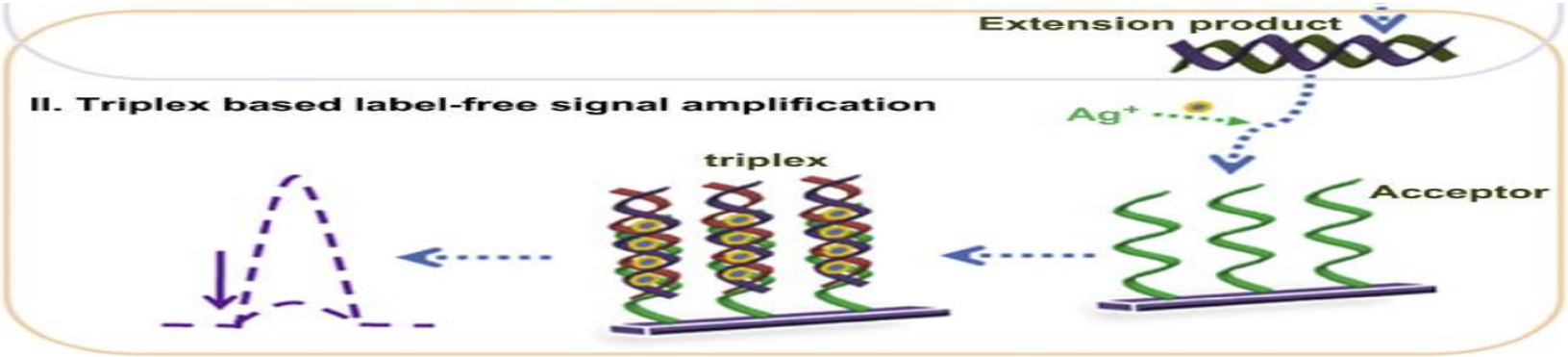


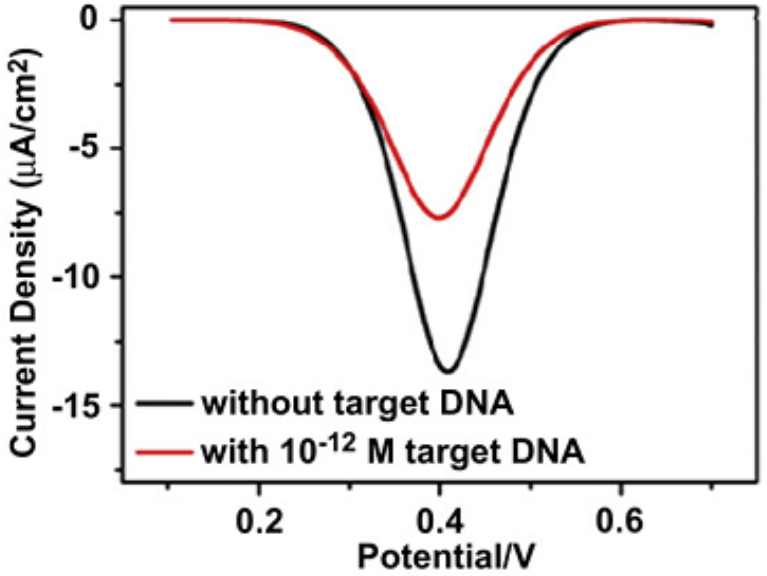


Autoradiogram of the gel retardation assay (GRA) of 50 nM duplex, 23RY (lane 1) (with hot 23Y) and mixtures of duplex 23RYand 15R in different mole ratios 2:1 (lane 2); 1:1 (lane 3) and 1:2 (lane 4).

J. Biosci. (2012) 37:519–532

Electrochemistry





The responses of 10^{-12} M target DNA by using the material of GSGHs

Biomaterials (2011) 32: 8584-8592

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How the DNA triplex can be stabilized?

Carbon Nanotubes

Synthetic compounds

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3670–3676 *Nucleic Acids Research, 2006, Vol. 34, No. 13*
doi:10.1093/nar/gkl513

Carbon nanotubes selective destabilization of duplex and triplex DNA and inducing B–A transition in solution

Xi Li, Yinghua Peng and Xiaogang Qu*

Division of Biological Inorganic Chemistry, Key Laboratory of Rare Earth Chemistry and Physics, Graduate School of the Chinese Academy of Sciences, Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, Changchun, Jilin 130022, China

Premilat et al. have measured the major groove width of GC-DNA (~1.35 nm) and AT-DNA (~1.75 nm) through fiber X-ray diffraction.

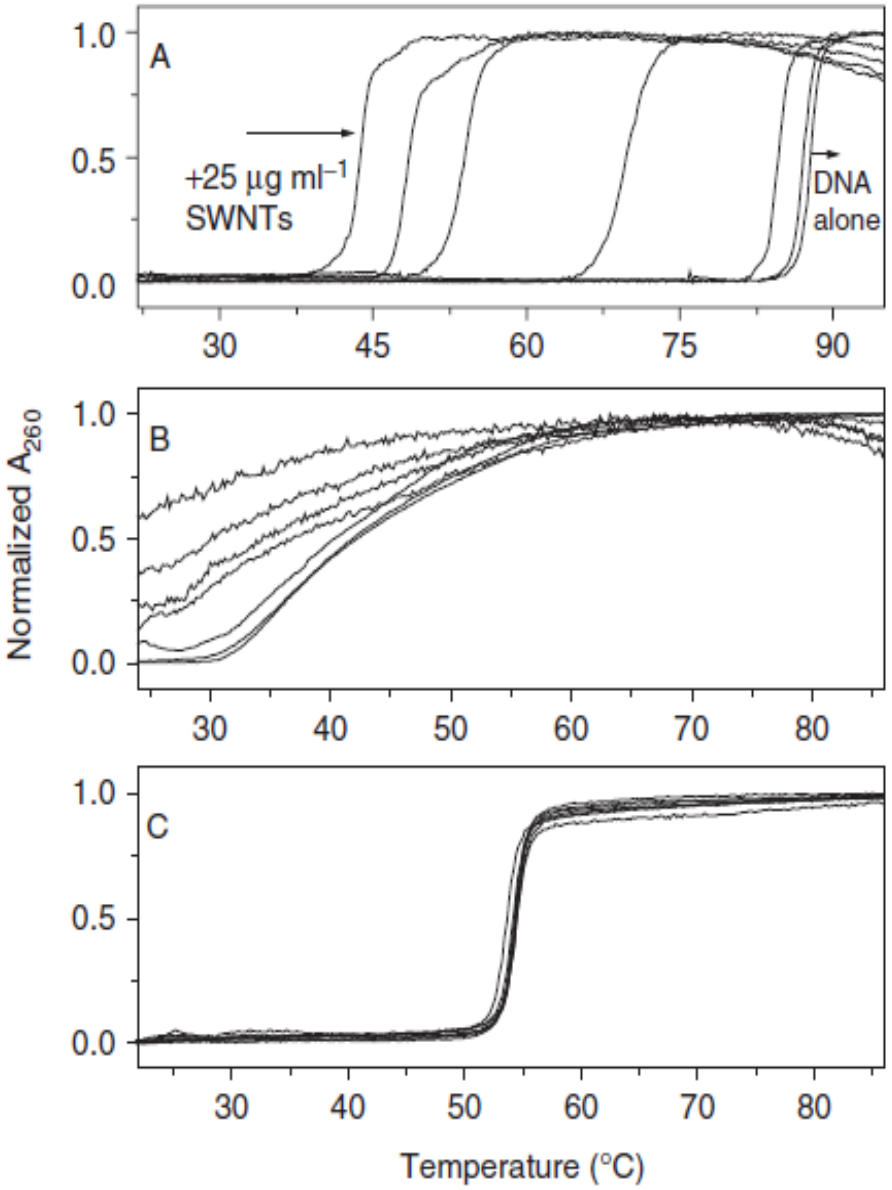
Eur. Biophys. J. (1991) 28, 574–582

Eur. Biophys. J. (2001) 30, 404–410

SWNTs (~1.1nm) we used were modified with carboxyl group. Carboxyl groups at the open end of SWNTs greatly increased their water solubility and may impact DNA binding to the modified nanotube surface.

Based on SWNTs size and their improved solubility, SWNTs should not bind to DNA minor grooves due to the narrower groove width. Alternatively, SWNTs may bind to the major groove and would fit better to GC-DNA major groove because AT-DNA major groove is too wide for SWNTs binding.

SWNTs selective destabilization of DNA

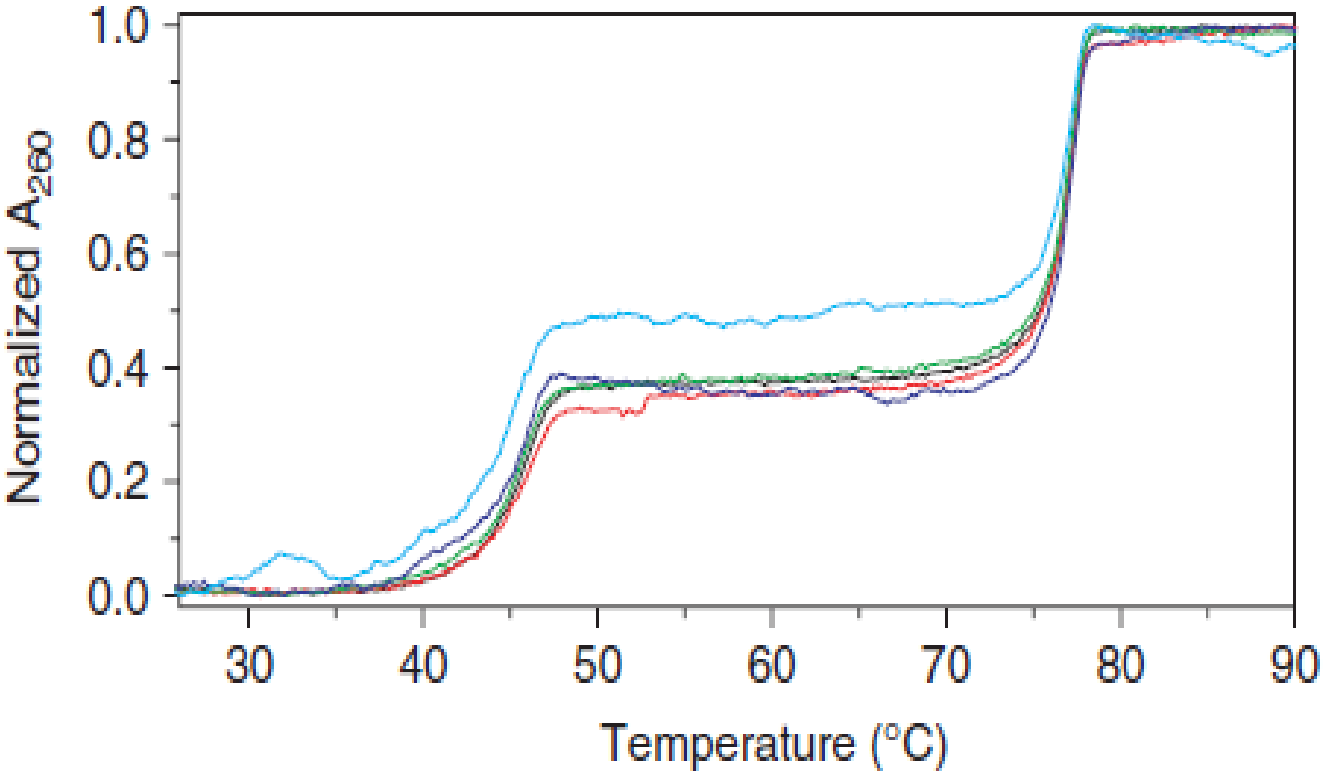


UV melting profiles of DNA: (A) poly[dGdC]:poly[dGdC], (B) ct-DNA, (C) poly[dAdT]:poly[dAdT] in the absence or presence of SWNTs. From right to left: 0, 1, 5, 10, 15, 20, 25 µg ml^{-1} SWNTs in pH = 7 solution.

It is obvious that GC-DNA and ct-DNA became unstable in the presence of SWNTs. Melting temperature Tm decreased 40ºC for GC-DNA when SWNTs at 25 µg ml^{-1}. The absorption after 80ºC decreased showing the strong interaction of single strand DNA with SWNTs.

DNA triplex polydA. $(polydT)_2$

Tm1 was decreased in the presence of SWNTs but Tm2 did not change, indicating that SWNTs competed with the third strand binding to the duplex major groove of polydA:polydT, thus decrease the stability of Hoogsteen base pairs but not influence the duplex stability of polydA:polydT.



UV melting profiles of DNA triplex polydA (polydT)2 in the absence or presence of SWNTs: SWNTs 1 μg ml^{-1}; 2 μg ml^{-1}; 5 μg ml^{-1}; 10 μg ml^{-1} in Tris buffer (10 mM Tris, 200 mM NaCl, pH=7.1). Normalized absorption changes at 260 nm were plotted against temperature.

Published online 16 May 2011

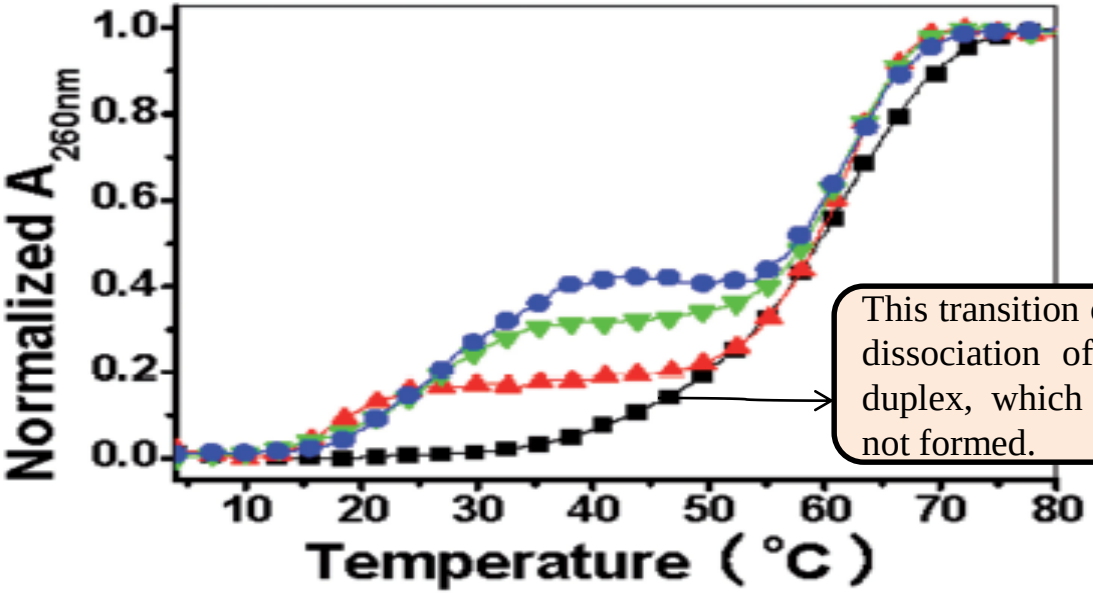
Nucleic Acids Research, 2011, Vol. 39, No. 15 ***6835–6843***
doi:10.1093/nar/gkr322

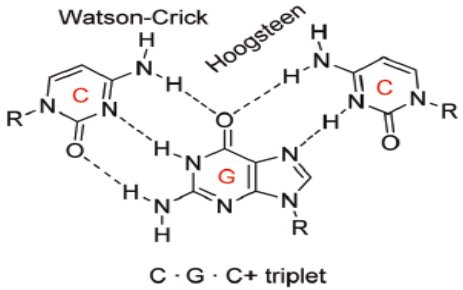
Stabilization of unstable CGC$^+$ triplex DNA by single-walled carbon nanotubes under physiological conditions

Yujun Song[1,2], Lingyan Feng[1,2], Jinsong Ren[1] and Xiaogang Qu[1,*]

[1]Division of Biological Inorganic Chemistry, State Key Laboratory of Rare Earth Resource Utilization, Laboratory of Chemical Biology, Changchun Institute of Applied Chemistry and [2]Graduate School of the Chinese Academy of Sciences, Chinese Academy of Sciences, 5625 Renmin Street, Changchun, Jilin 130022, China

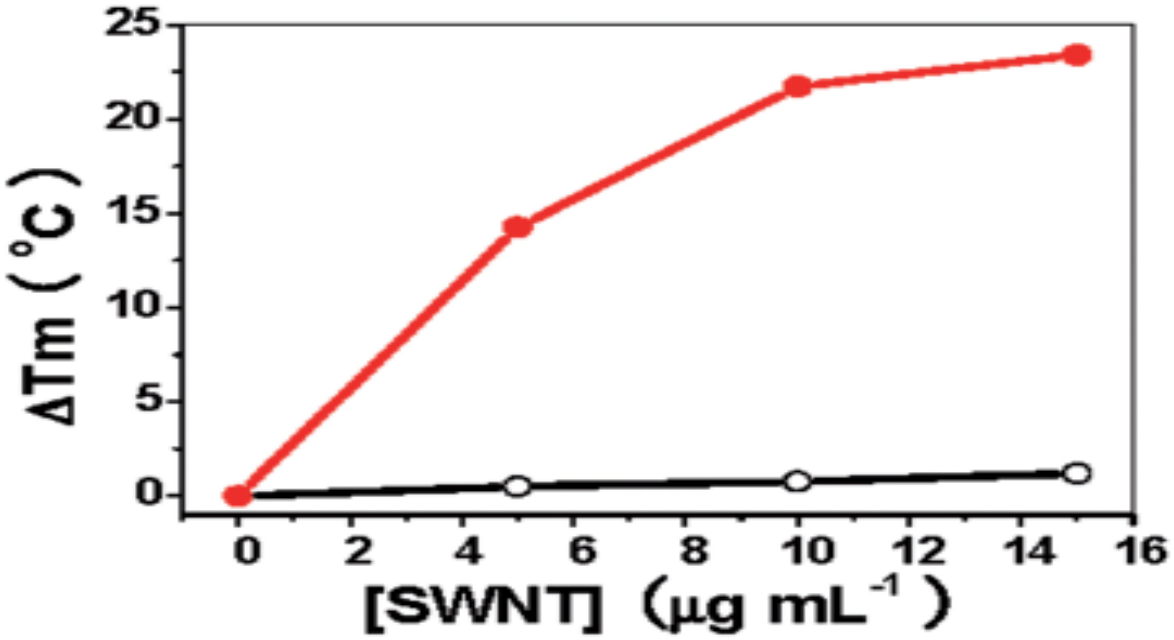
GAG AGG AGA GAG AAG AGG AAG
CTC TCC TCT CTC TTC TCC TTC





This transition corresponds to the dissociation of a Watson–Crick duplex, which reveals triplex is not formed.

UV melting profiles of 1 mM d(CT)·d(AG) in the absence or presence of SWNTs: 5 µg ml^{-1} ,10 µg ml^{-1}, 15 µg ml^{-1} in cacodylic buffer (1mM cacodylic acid /sodium cacodylate/200mM NaCl/pH 6.5).



Plot of Tm (the difference in the apparent Tm in the presence of SWNTs relative to d(CT)·d(AG). Filled circles are for the transition for dissociation of the third strand. Tm3-2 (triplex→duplex+single strand) is calculated by assuming a Tm3-2 of 4 ºC in the absence of SWNTs (no transition seen). Open circles are for the duplex melting transition.

SWNT vs MWNT

As SWNTs can induce the perfect matched DNA triplex formation while MWNTs do not have the effect, which suggests the diameter of nanotubes is very important for DNA binding. MWNTs (10–20 nm-sized) are too large to bind to the major groove. In our previous study, SWNTs (1.1 nm sized) can bind to the groove of TAT DNA triplex and decrease the stability of TAT DNA triplex. In the present study, this selectivity can be attributed to the size of the groove and negatively charged carboxyl-modified SWNTs binding to the groove can further stabilize CGC+ DNA triplex.

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Biochimie 92 (2010) 514–529

Contents lists available at ScienceDirect

Biochimie

journal homepage: www.elsevier.com/locate/biochi

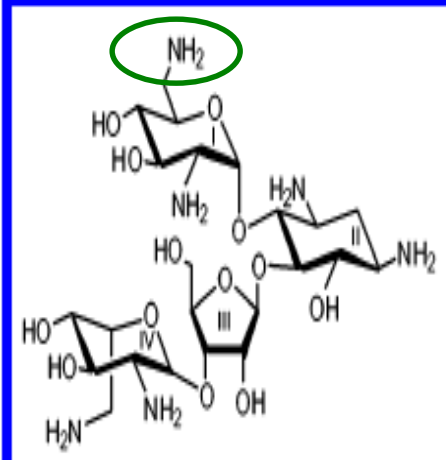
Research paper

Calorimetric and spectroscopic studies of aminoglycoside binding to AT-rich DNA triple helices

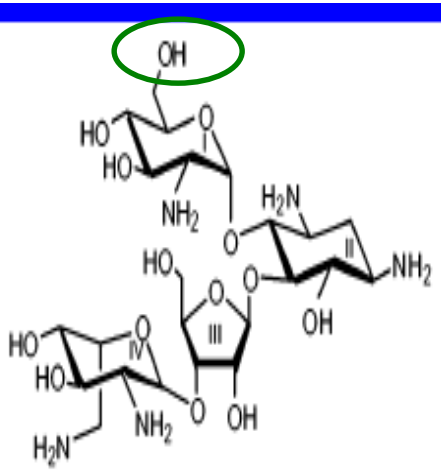
Hongjuan Xi, Sunil Kumar, Ljiljana Dosen-Micovic, Dev P. Arya*

Contribution from the Laboratory of Medicinal Chemistry, Department of Chemistry, Clemson University, Clemson, SC 29634, USA

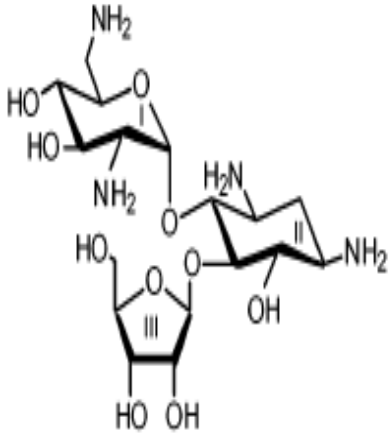
Aminoglycoside antibiotics



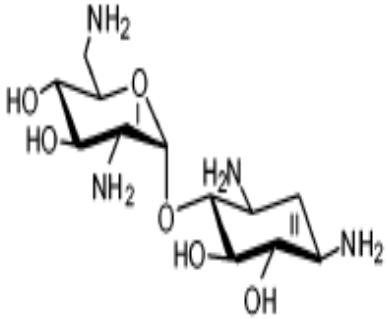
Neomycin



Paromomycin



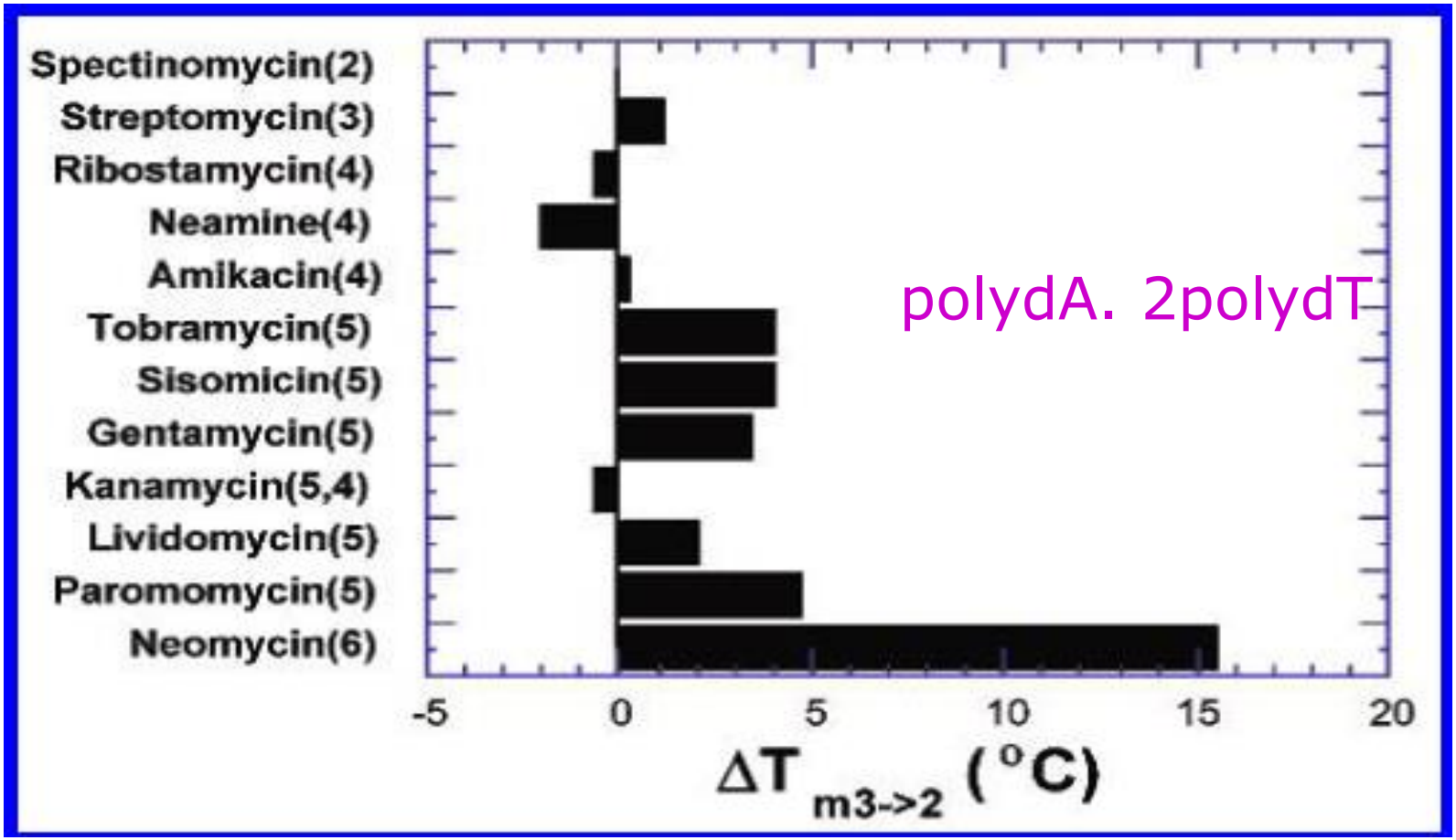
Ribostamycin



Neamine

Aminoglycoside can bind to RNA duplex, A-form DNA duplex, DNA-RNA hybrid duplex, DNA triplex, and RNA triplex.

Melting Curves of Aminoglycoside



Change in Tm $_{3\text{-}2}$ (rdb =0.67), where rdb =ratio of the drug/base triplet, on the stabilization of the polydA. 2polydT triplex melt in the presence of 150 mM KCl. Without any aminoglycoside present, the melting temperature of the triplex was 34.0 °C. Buffer conditions: 10 mM sodium cacodylate, 0.5 mM EDTA, pH 7.2. The melting rate was 0.2 °C/min.
Number of amines in each drug is shown in parentheses.

Biochemistry **1993,** *32,* 14068–14074

Selectivity of Polyamines in Triplex DNA Stabilization†

Thresia Thomas and T. J. Thomas*

Department of Environmental and Community Medicine and Program in Clinical Pharmacology, Clinical Research Center, University of Medicine and Dentistry of New Jersey–Robert Wood Johnson Medical School, New Brunswick, New Jersey 08903

Received August 6, 1993; Revised Manuscript Received October 11, 1993®

Biochem. J. (1996) **319**, 591–599 (Printed in Great Britain)

Structural specificity effects of trivalent polyamine analogues on the stabilization and conformational plasticity of triplex DNA

T. J. THOMAS*§¶††, Gayathri D. KULKARNI*§, Norma J. GREENFIELD†, Akira SHIRAHATA** and Thresia THOMAS‡§‖¶

Departments of *Medicine, †Neuroscience and Cell Biology, and ‡Environmental and Community Medicine, §Clinical Research Center, ‖Environmental and Occupational Health Sciences Institute, and the ¶Cancer Institute of New Jersey, University of Medicine and Dentistry of New Jersey-Robert Wood Johnson Medical School, New Brunswick, NJ 08903, U.S.A. and **Faculty of Pharmaceutical Sciences, Josai University, Sakado, Saitama 350-02, Japan

Polyamines

n=3

Putrescine: $(H_2N(CH_2)_nNH_2)$

n=4

Spermidine: $(H_2N(CH_2)_nNH(CH_2)_3NH_2)$

Spermine: $(H_2N(CH_2)_3NH(CH_2)_4NH(CH_2)_5NH_2)$

Cobalt hexamine $[Co(NH_3)_6{}^{3+}]$

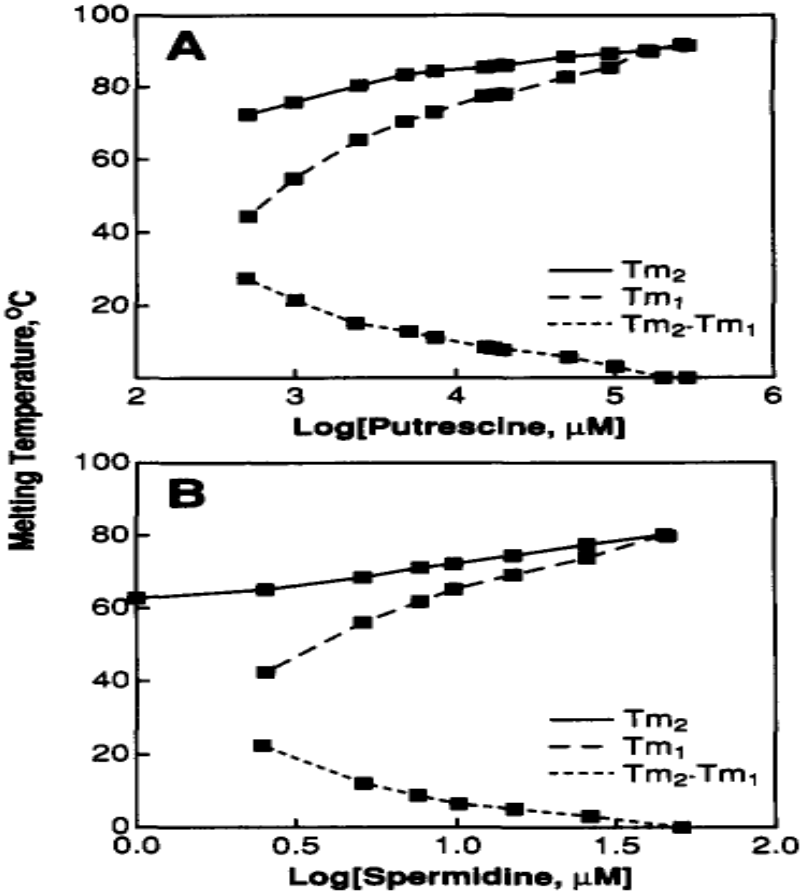


FIGURE 2: Effect of putrescine (A) and spermidine (B) concentrations on the melting temperatures of triplex (T_{m1}) and duplex (T_{m2}) forms of DNA. The differences between T_{m2} and T_{m1} at each polyamine concentration are also plotted.

poly(dA). 2poly(dT)

Biophysical Chemistry 145 (2009) 105–110

Contents lists available at ScienceDirect

Biophysical Chemistry

journal homepage: http://www.elsevier.com/locate/biophyschem

The stability of triplex DNA is affected by the stability of the underlying duplex

David A. Rusling [a,1], Phillip A. Rachwal [a,2], Tom Brown [b], Keith R. Fox [a,*]

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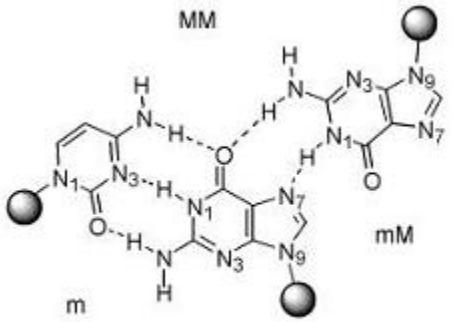
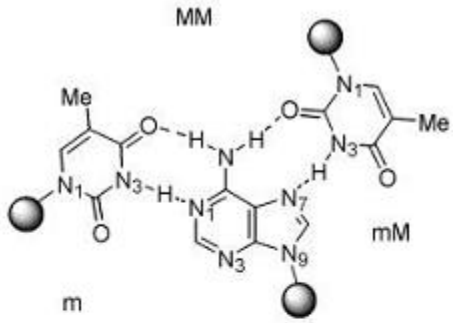
[b] School of Chemistry, University of Southampton, Highfield, Southampton SO17 1BJ, UK

Prof. Tom Brown

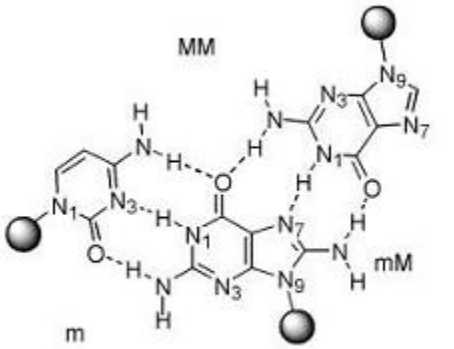
Prof. Keith R. Fox



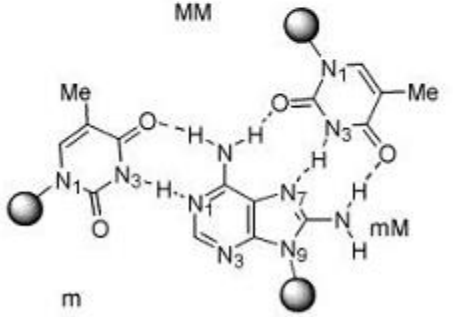
d(G#G·C)



d(T#A·T)



d(G#8AG·C)



d(T#8AA·T)

Thanks

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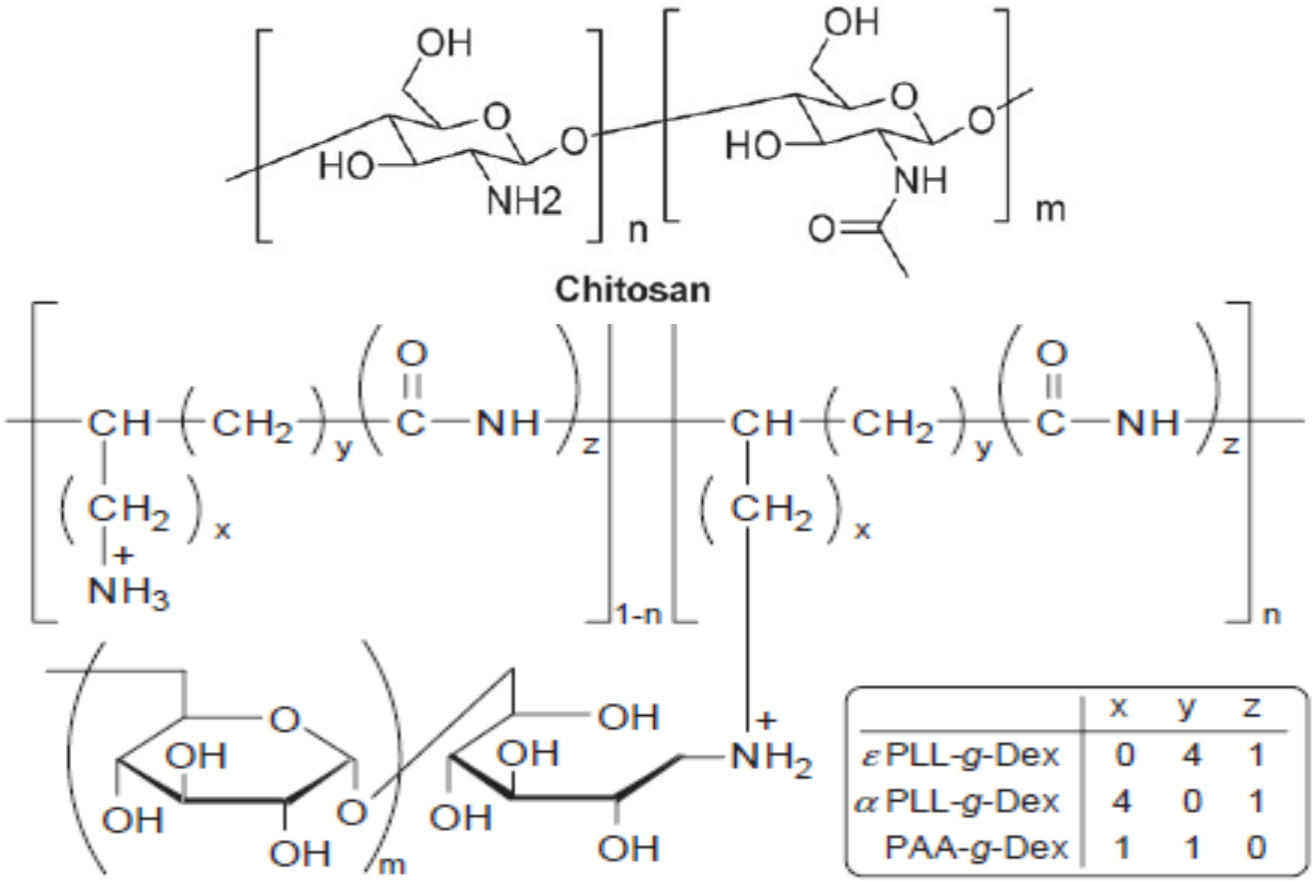
Biomaterials 26 (2005) 703–711
Biomaterials
www.elsevier.com/locate/biomaterials

The effect of backbone structure on polycation comb-type copolymer/DNA interactions and the molecular assembly of DNA

Yu-ichi Sato[a], Yuki Kobayashi[b], Takayuki Kamiya[b], Hiromitsu Watanabe[b], Toshihiro Akaike[b], Kenichi Yoshikawa[c], Atsushi Maruyama[a,b,*]

[a] *PRESTO, Japan Science and Technology Agency, 4-1-8 Honcho, Kawaguchi, Saitama 332-0012, Japan*
[b] *Department of Biomolecular Engineering, Graduate School of Bioscience and Biotechnology, Tokyo Institute of Technology, 4259 Nagatsuta-cho, Midori, Yokohama 226-0026, Japan*
[c] *Department of Physics, Graduate School of Science, Kyoto University, Sakyo-ku, Kyoto 606-8502, Japan*

Received 17 February 2004; accepted 13 March 2004



	x	y	z
ε PLL-*g*-Dex	0	4	1
α PLL-*g*-Dex	4	0	1
PAA-*g*-Dex	1	1	0

Structural formulas of graft copolymers

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Review

Chitosan microspheres as a potential carrier for drugs

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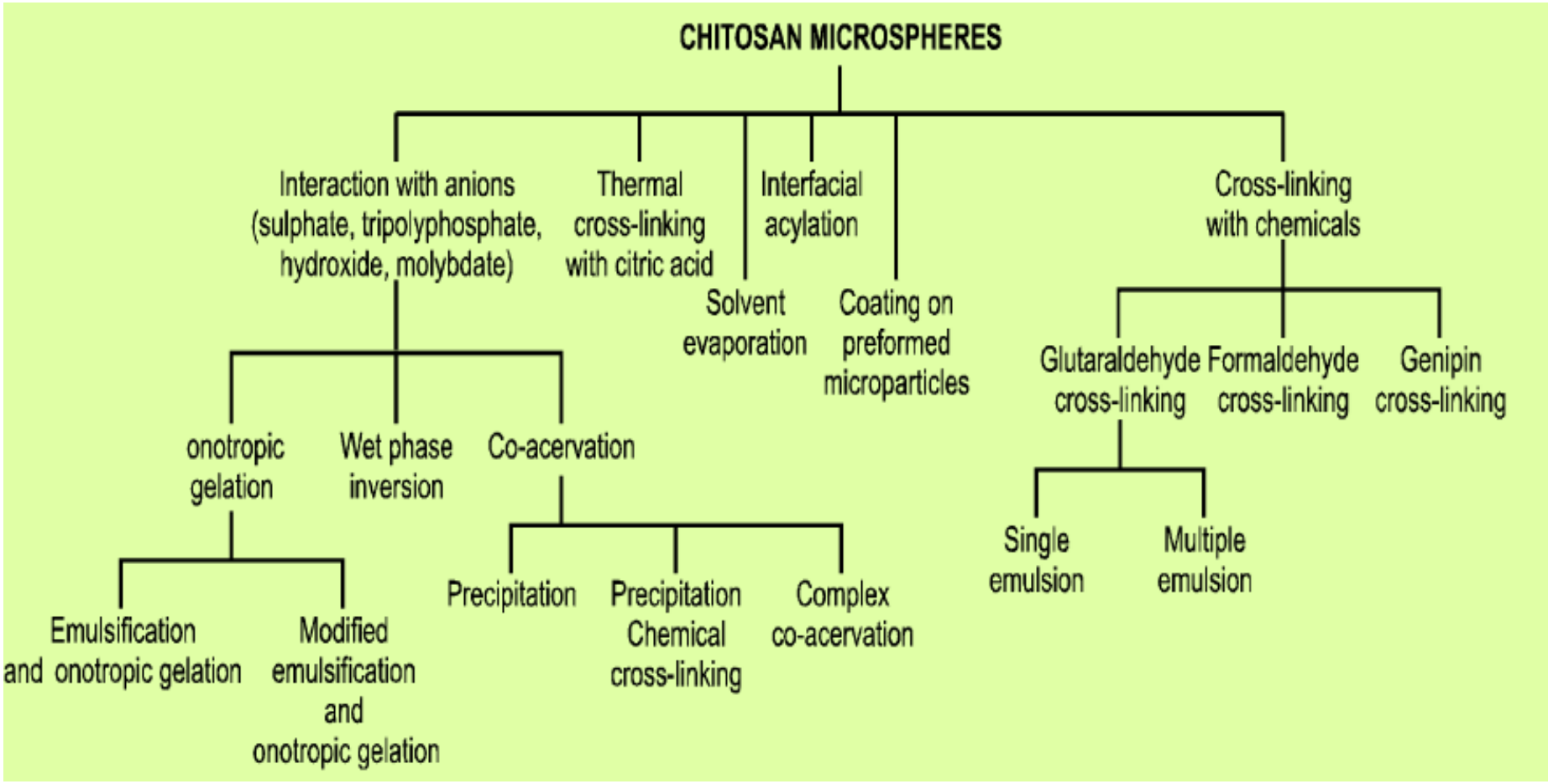
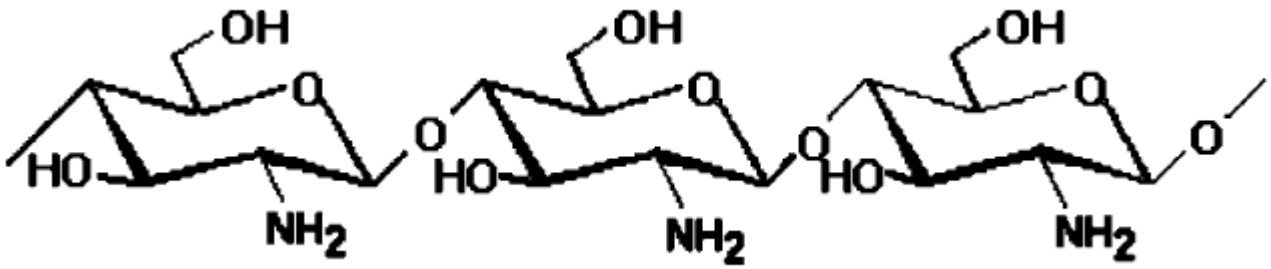

CHITOSAN MICROSPHERES
Interaction with anions (sulphate, tripolyphosphate, hydroxide, molybdate)
Thermal cross-linking with citric acid
Interfacial acylation
Solvent evaporation
Coating on preformed microparticles
Cross-linking with chemicals
Glutaraldehyde cross-linking
Formaldehyde cross-linking
Genipin cross-linking
Single emulsion
Multiple emulsion
onotropic gelation
Wet phase inversion
Co-acervation
Emulsification and onotropic gelation
Modified emulsification and onotropic gelation
Precipitation
Precipitation Chemical cross-linking
Complex co-acervation


OH
O
HO
NH2
O
OH
O
HO
NH2
O
OH
O
HO
NH2
O

BCL2

AAA AAA GAG GAG AAG AAA AAA

TTT TTT CTC CTC TTC TTT TTT

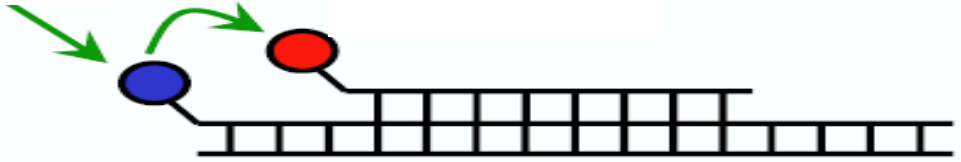
A proto-oncogene which encodes for 25KD protein which has a peculiar function of blocking programmed cell death without affecting proliferation.

(i) a length of at least 18 nt for the target sequence, (ii) at least 40% guanine in the target sequence, (iii) no stretches of more than seven adenines.

7. Biochemistry (2002) 41:357–366

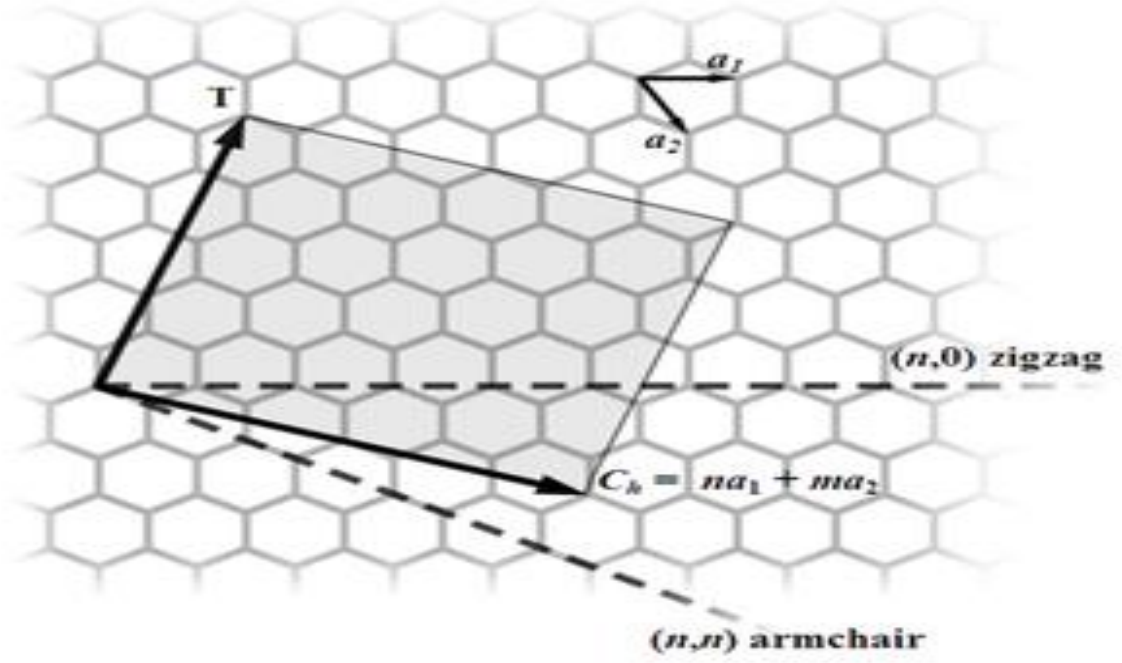
(iv) no long stretches of guanines (more than four) and no multiple repetitions of stretches of three or more guanines.

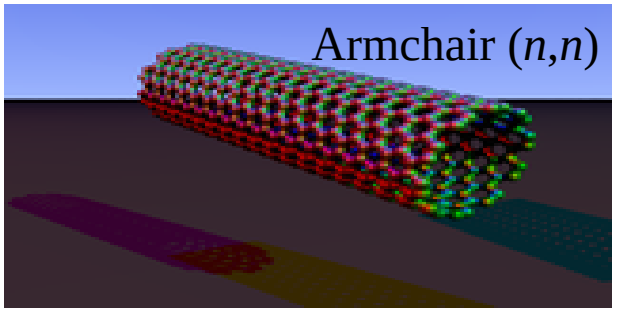
8. Biochemistry (1995) 34:278–284

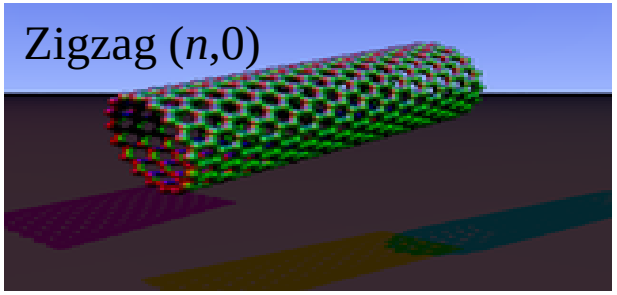


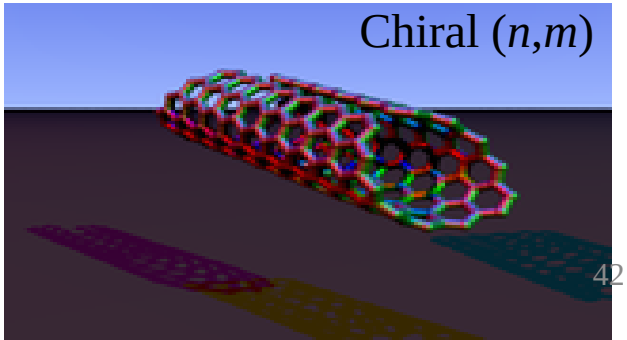
The way the graphene sheet is wrapped is represented by a pair of indices (*n*,*m*). The integers *n* and *m* denote the number of unit vectors along two directions in the honeycomb crystal lattice of graphene.

$$d = \frac{a}{\pi}\sqrt{(n^2 + nm + m^2)}.$$

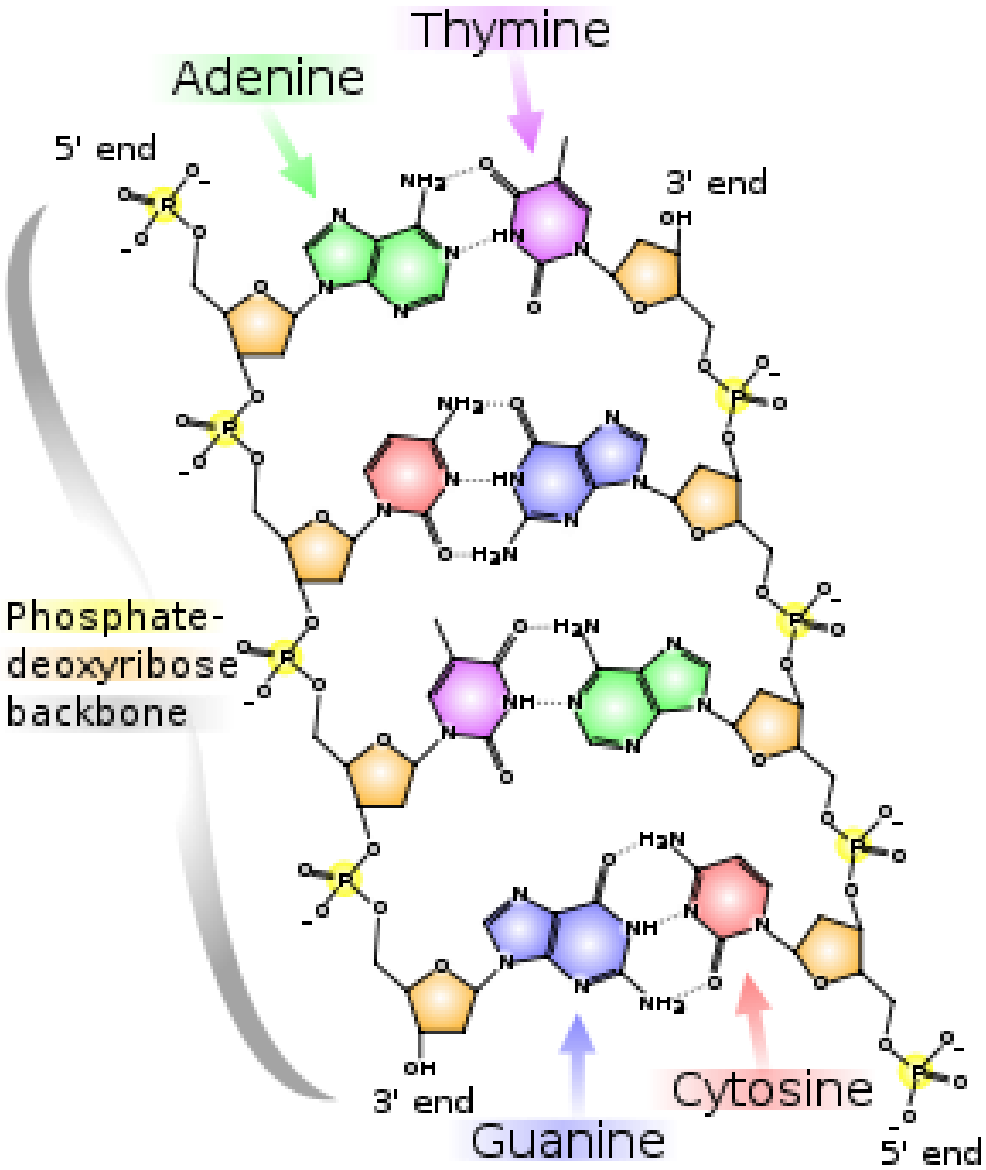








The (*n*,*m*) nanotube naming scheme can be thought of as a vector ($\mathbf{C}_h$) in an infinite graphene sheet that describes how to "roll up" the graphene sheet to make the nanotube. In fact, a simple way to classify each nanotube structure is a vector which connects tow points on the graphene lattice and it is designated with Ch. **T** denotes the tube axis, and $\mathbf{a}_1$ and $\mathbf{a}_2$ are the unit vectors of graphene in real space.


Thymine
Adenine
5' end
3' end
Phosphate-
deoxyribose
backbone
3' end
Guanine
Cytosine
5' end

UV absorbance is a commonly used method and considered as the golden standard, it is limited by:

1) a relatively low sample throughput;
2) the need for relatively large amounts of oligonucleotides;
3) a relatively low switch in absorbance level upon melting;
4) the possibility for overlapping peaks for each strand composition in the melting profile

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RESEARCH PAPER

Attachment of biomolecules (protein and DNA) to amino-functionalized carbon nanotubes

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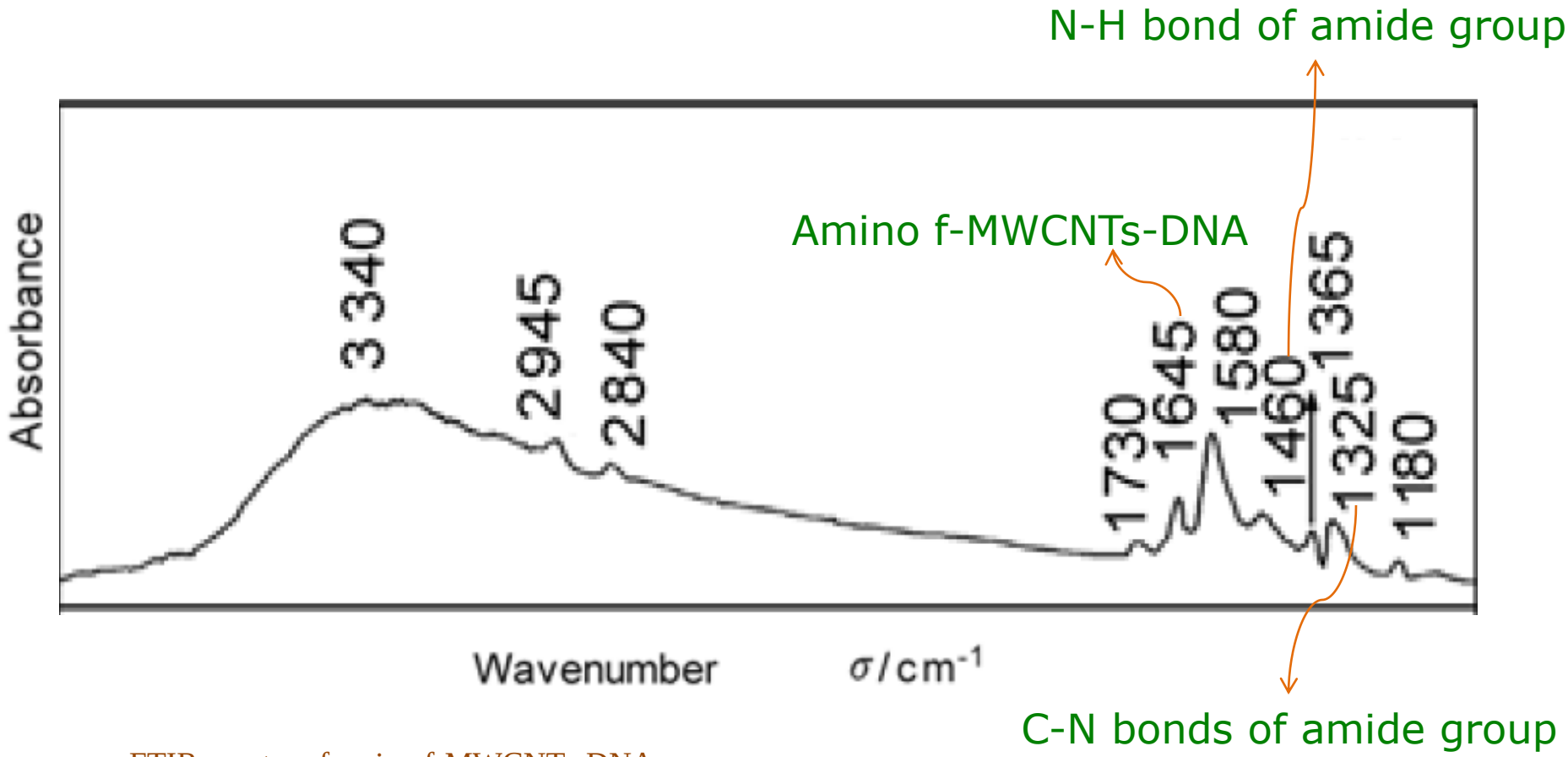
Functionalization of MWCNTs and attachment of biomolecules to the amino-functionalized MWCNTs



FTIR spectra of amino f-MWCNTs-DNA