Literature Report

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FULL PAPER

Non Invasive Regulation of Cellular Morphology Using a Photoswitchable Mechanical DNA Polymer

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Kyoto University

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Organization for Research and Development of Innovative Science and Technology
Kansai University

Authors introduce

Name(Kanji/Kana/Abecedarium Latinum)

杉山 弘/スギヤマ ヒロシ/Sugiyama, Hiroshi

DNAを中心としたケミカルバイオロジー研究

Chemical Biology of DNA

Work Experience

Period	Organization(Japanese)	Organization(English)	Job title(Japanese)	Job title(English)
1984-1986	米国ヴァージニア大学	University of Virginia, Charlottesville, USA	博士研究員	Postdoctoral Fellow
1986-1987	日本学術振興会	JSPS	特別研究員	JSPS Research Associate
1987-1993	京都大学 工学部 合成化学科	Bioorganic Chemistry, Kyoto University	助手	Assistant Professor
1993-1996	京都大学 工学部 合成化学科	Bioorganic Chemistry, Kyoto University	助教授	Associate Professor
1996-2003	東京医科歯科大学	Tokyo Medical and Dental University	教授	Professor
2003-	京都大学 大学院理学研究科 化学専攻	Graduate School of Science, Kyoto University	教授	Professor
2008-	京都大学 物質－細胞統合システム拠点	iCeMS, Kyoto University	連携主任研究者	Principal Investigator

Overview of the research

(Japanese)

杉山グループでは核酸の生物有機化学を行っている。合成化学と分子生物学の手法を用いて、核酸の分子認識、反応性と構造について研究している。核酸を物質としてこのように一般的にそして基本的に研究しているグループは他にない。グループでは以下の領域での研究を具体的に行っている。DNAの塩基のアルキル化、水素引き抜き、電子移動によるDNAの修飾についての分子機構の解明。抗癌性抗生物質の作用機構の理解に基づいた配列特異的なアルキル化剤の開発。DNAの局所構造の解析法の開発。細胞の分化や病気の治療を目指した人工遺伝子スイッチの開発を長期的な目標としている。

(English)

Professor Sugiyama's research interests involve the bioorganic chemistry of nucleic acids. Using the tools of synthetic physical organic chemistry and molecular biology, the Sugiyama group is defining the chemical principles underlying the recognition, reactivity and structure of nucleic acids. There are no other research groups on such a general and fundamental aspect of nucleic acids as a substance.The group utilizes a chemical approach in following areas: Molecular mechanism of DNA modification by DNA base alkylation, hydrogen abstraction and charge transfer. Design of highly efficient sequence-specific DNA acting agents based on understanding of the action mechanism of antitumor antibiotics. Design of unnatural nucleic acid for understanding of nucleic acid structure and function. Development of a method probing DNA local conformation in vivo. The long-range goal is creation of artificial genetic switches for targeted cell differentiation and treatment of many diseases.

Authors introduce

Name(Kanji/Kana/Abecedarium Latinum)

遠藤 政幸/エンドウ マサユキ/Endo, Masayuki

DNAナノテクノロジー　DNA nanotechnology

生物有機化学　Bioorganic Chemistry

ケミカルバイオロジー　Chemcal Biology

Work Experience

Period	Organization(Japanese)	Organization(English)	Job title(Japanese)	Job title(English)
2001-2005	大阪大学産業科学研究所	ISIR, Osaka University	助手	Assistant Professor
2005-2008	大阪大学産業科学研究所	ISIR, Osaka University	特任助教授・准教授	Associate Professor
2008-	京都大学物質ー細胞統合システム拠点	WPI-iCeMS, Kyoto University	准教授	Associate Professor

Research Topics

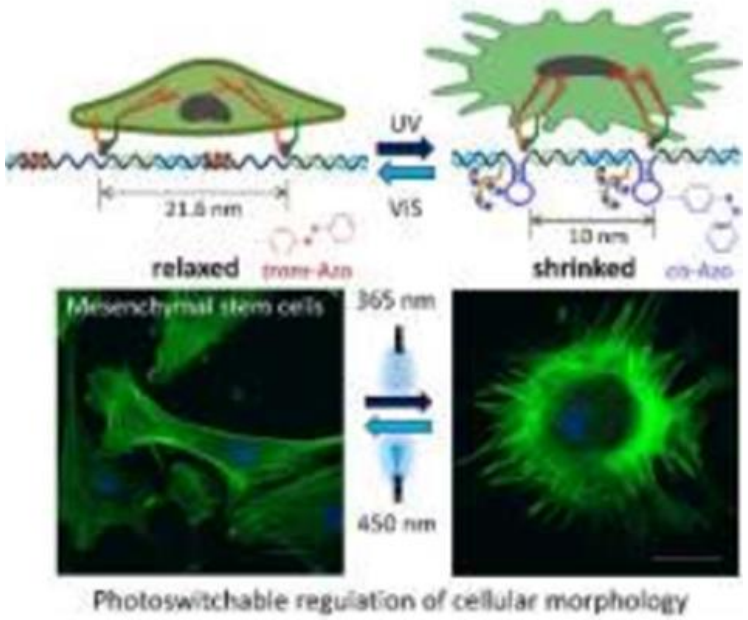
(Japanese)

1. 新規な多次元DNAナノ構造の設計と構築と機能化 2. DNAナノ構造体のプログラム多次元配列化 3. DNAナノ空間を使用した化学反応や生化学反応の制御 4. 生体機能の解明のための1分子イメージング 5. DNAナノ空間での生体分子の物性の解明 6. 新規なDNA結晶の開発と物性の解明 7. 1分子で機能する多様な分子デバイスの開発 8. 光学特性を持つナノデバイスの開発 9. 分子機械と分子ロボットへの応用 10. 細胞機能を制御する分子システムの開発 11. 診断・治療など生体への応用

(English)

1. Constuction & functionalization of novel DNA nanostructures 2. Programmed DNA nanosystem for multidimentional assembly and arrangements 3. Control of biomolecular reactions using a designed DNA nanospace 4. AFM-based single-molecule visualization of biomolecules in a designed DNA nanoscaffold 5. Single-molecule analysis of physical properties of biomolecules in a designed nanospace 6. Development of novel DNA crystals 7. Development of single-molecule switches and nanodevices 8. Development of photonic nanomaterilas 9. Applications for molecular nanomachines and molecular robotics 10. Development of novel delivery system for cellular applications 11. Diagnosis and medical applications

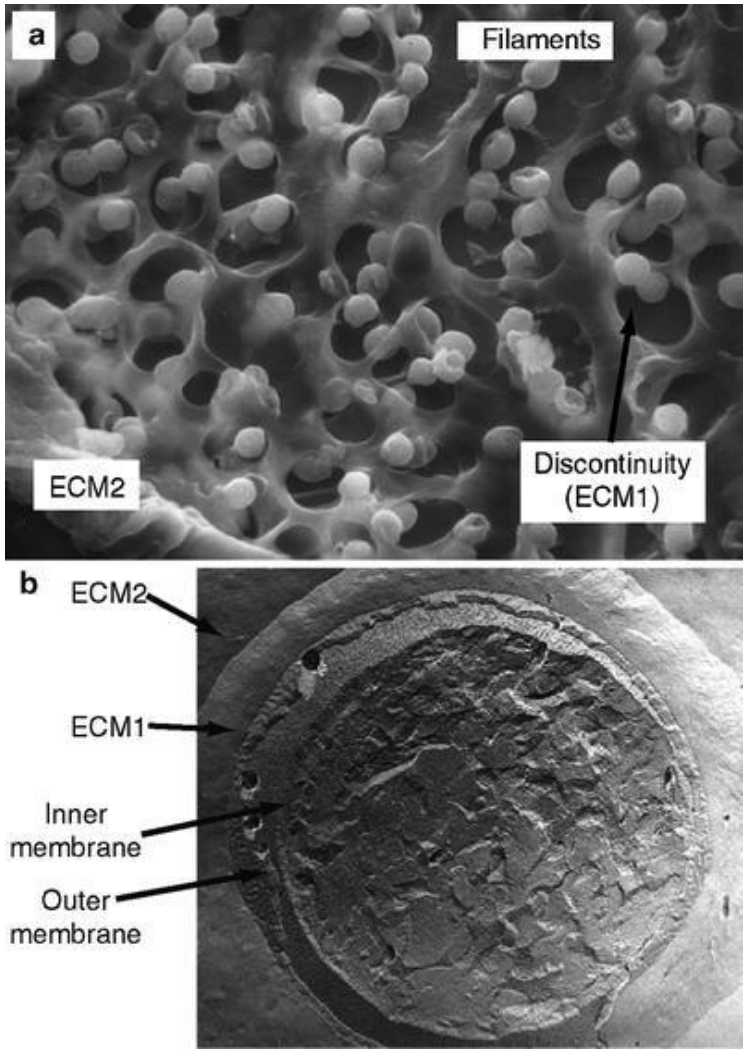
Introduction



Photoswitchable regulation of cellular morphology

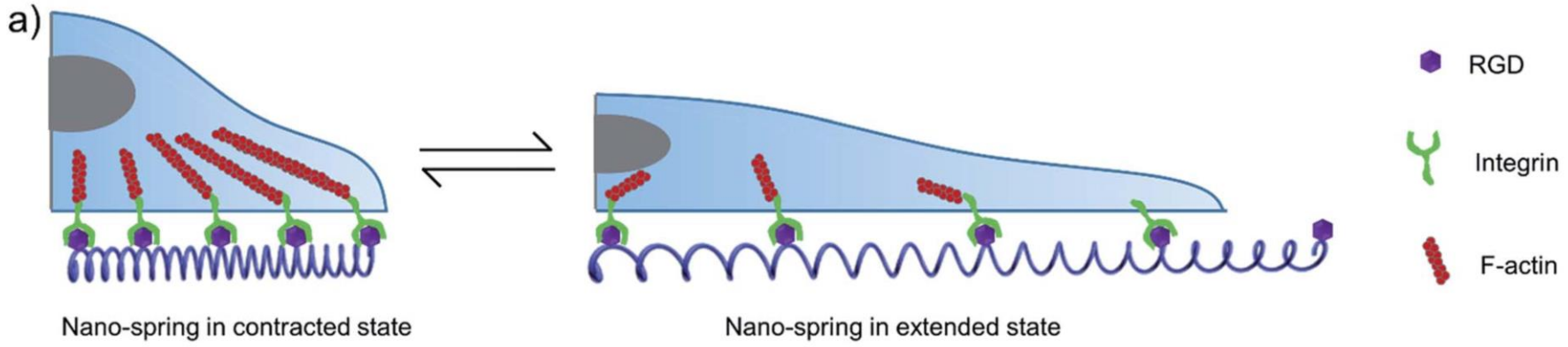
All cells make close contact with the extra-cellular matrix (ECM), The ECM is well known for its ability to provide structural support for organs and tissues, for cell layers in the form of basement membranes, and for individual cells as substrates for migration. The role of the ECM in cell adhesion and signaling to cells through adhe-sion receptors such as integrins has received much attention and, more recently, mechanical characteristics of the matrix (stiffness, deformability) have also been recognized to provide inputs into cell behavior Thus, ECM proteins and structures play vital roles in the determination, differentiation, proliferation, survival, polarity, and migration of cells.

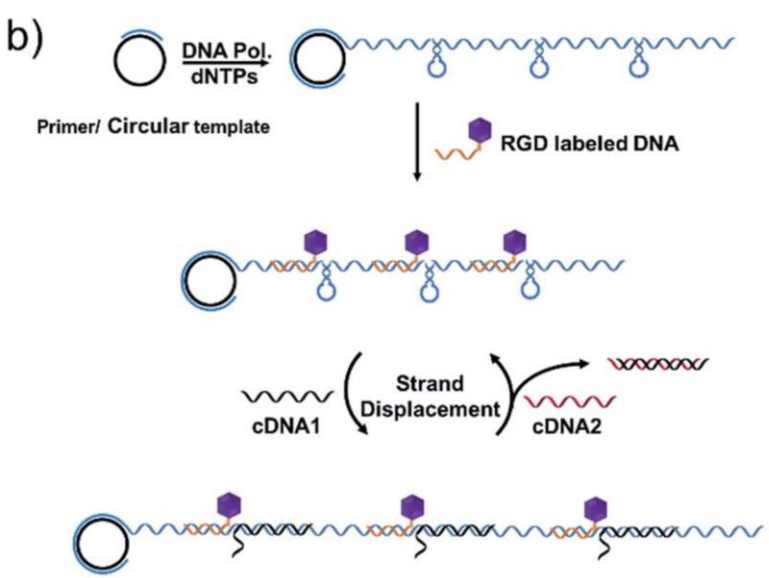
Science (2009):326, 5957, 1216-1219

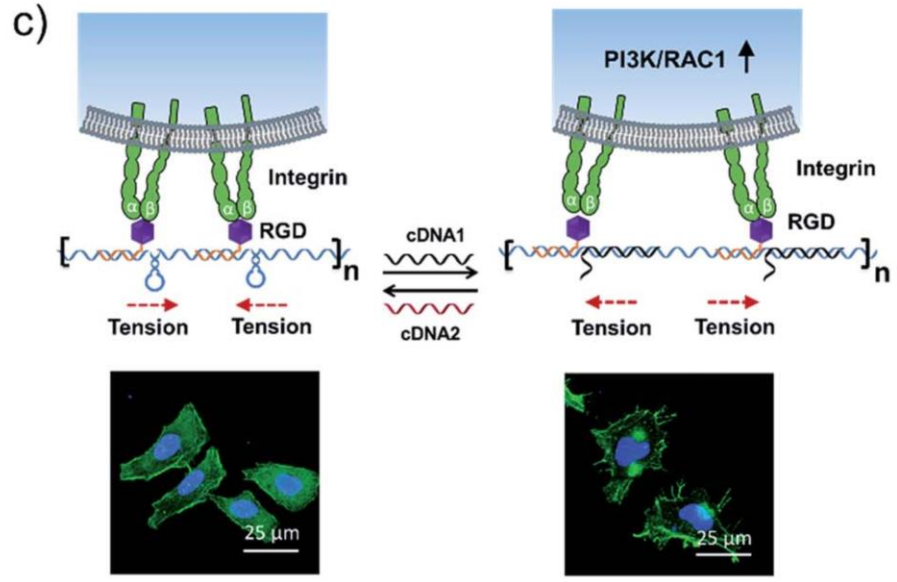


Helm R.F., Potts M. (2012)

Introduction

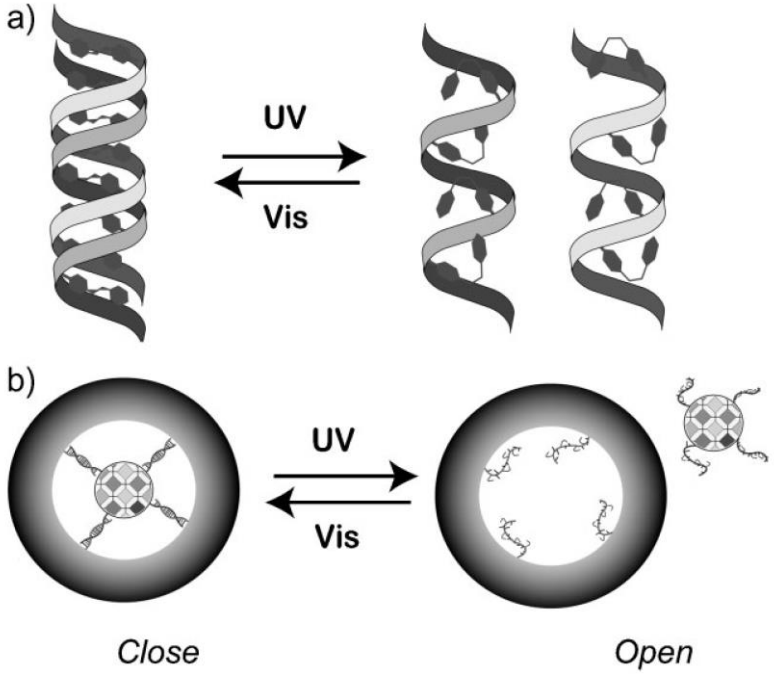






Chem. Sci., 2017, 8, 7098–7105

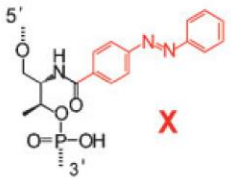
Introduction



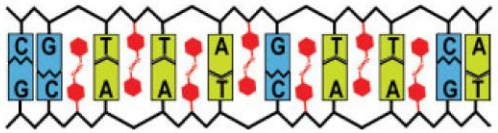
光开关的DNA杂交策略

a)

Name	Sequence
A-n	5'-CGTTAGTTCA-3'
B-n	3'-GCAATCAAGT-5'
A3X	5'-CG TXT AXG TXT CA-3'
B4X	3'-GCXA AXT CXA AXGT-5'
A3X-A	5'-CG TXT AXA TXT CA-3'
A3X-C	5'-CG TXT AXC TXT CA-3'
A3X-T	5'-CG TXT AXT TXT CA-3'
P-n	5'-GTATGCATAC-3'
P2X	5'-GTXATGCAXTAC-3'
P4X	5'-GTXATXGCAXTAXC-3'
Hp6X	5'-TTXGTXTAXCCAGTTTTCTGXGTXAAXCAA-3'
Hp-n	5'-TTGTTACCAGTTTTCTGGTAACAA-3'



Duplex A3X / B4X:



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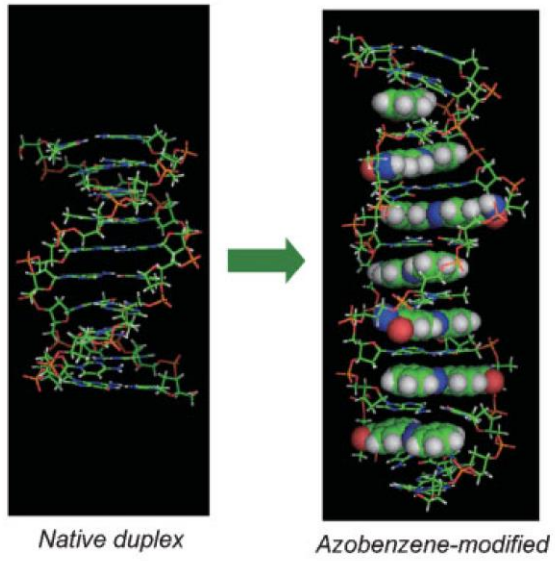
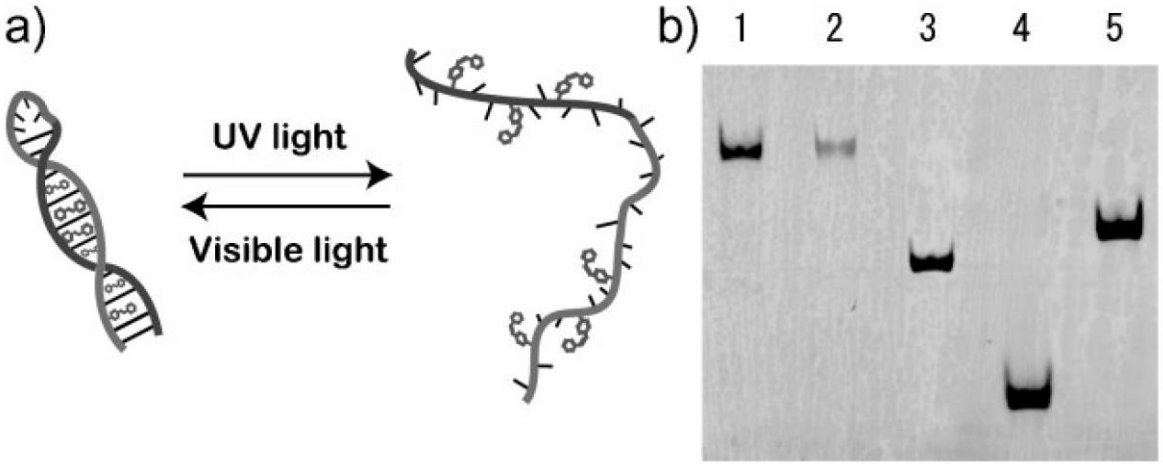
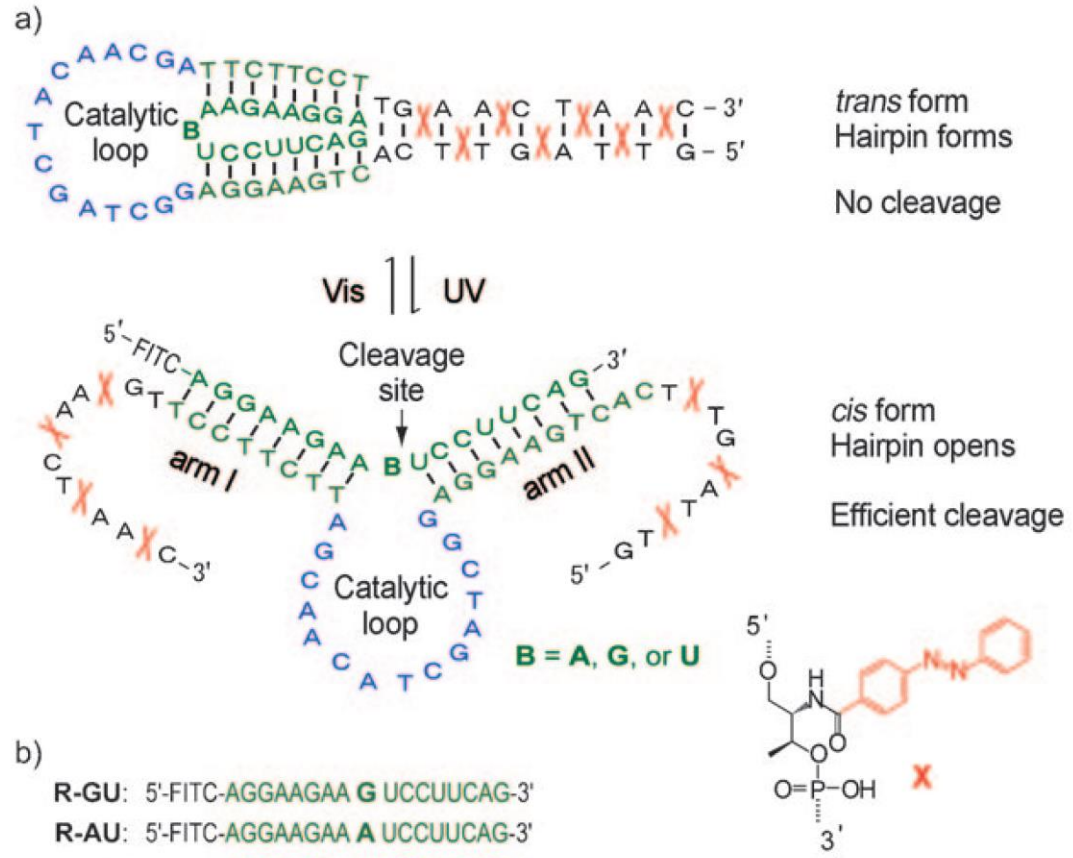
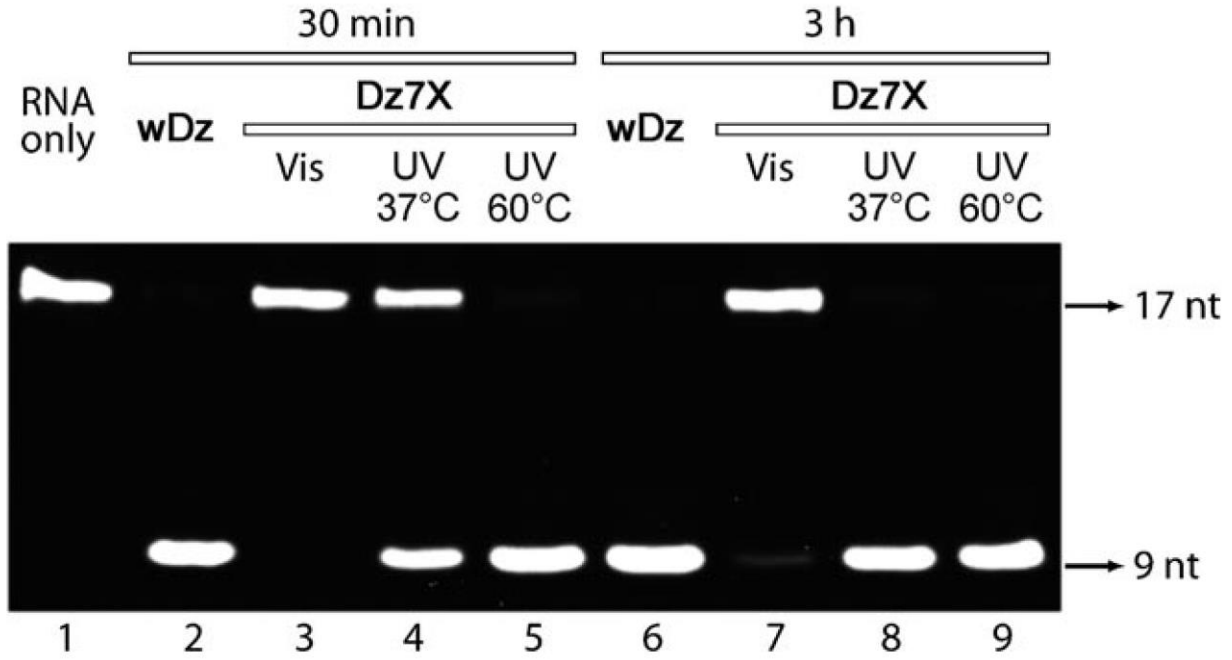




Small 2009, 5, No. 15, 1761–1768

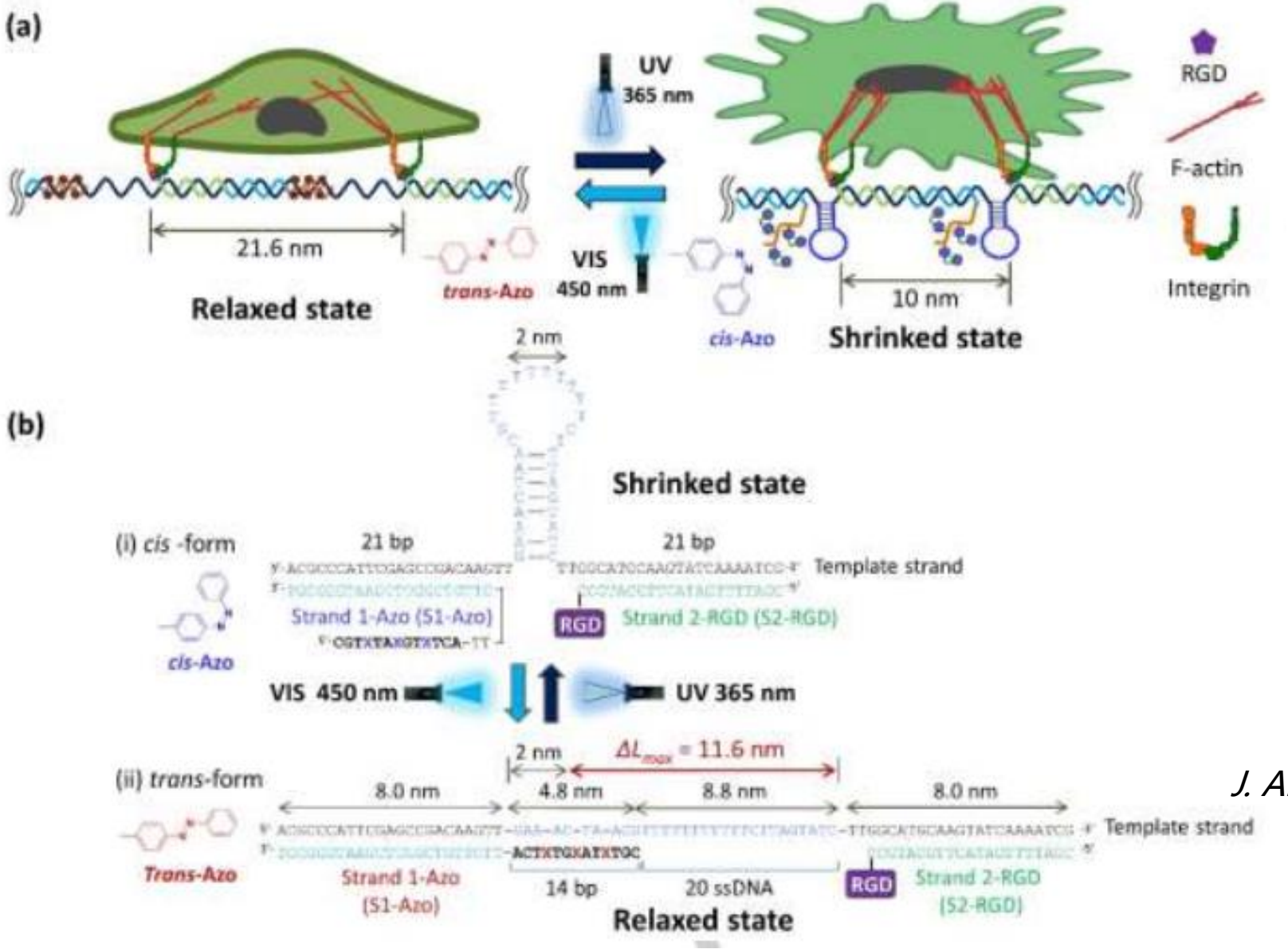
Introduction

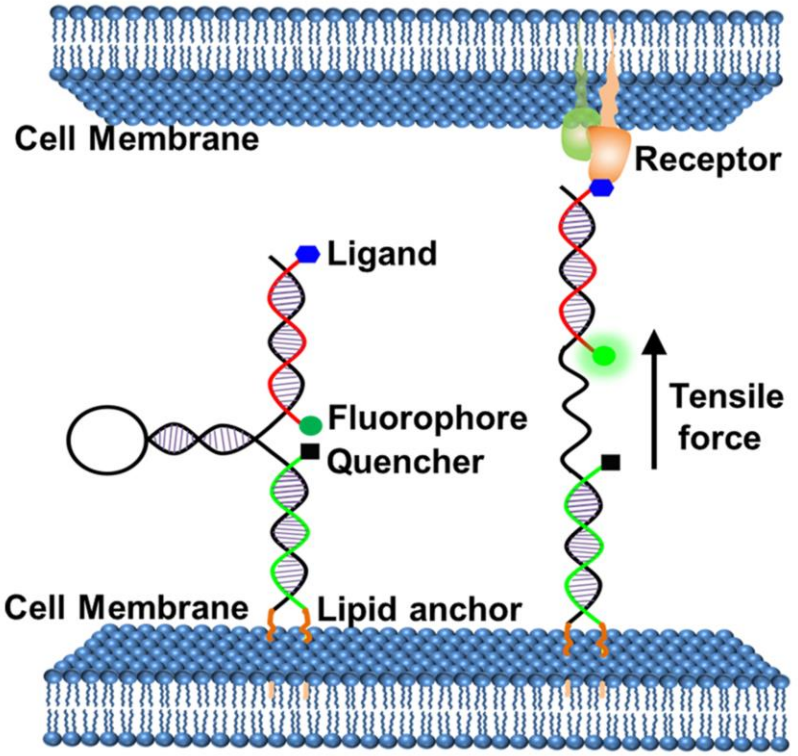




Angew. Chem. Int. Ed. 2010, 49, 2167 –2170

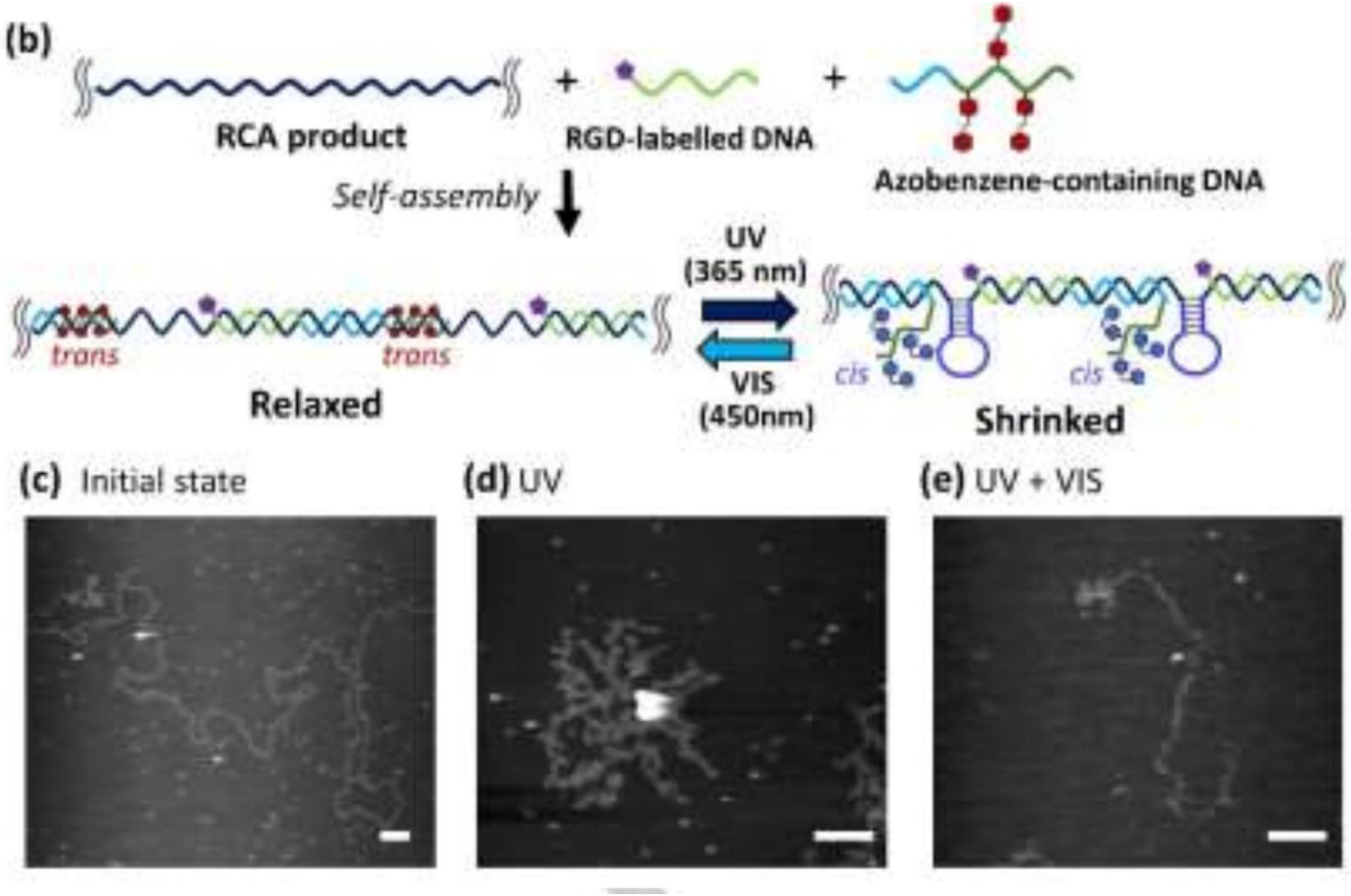
Result and Discussion

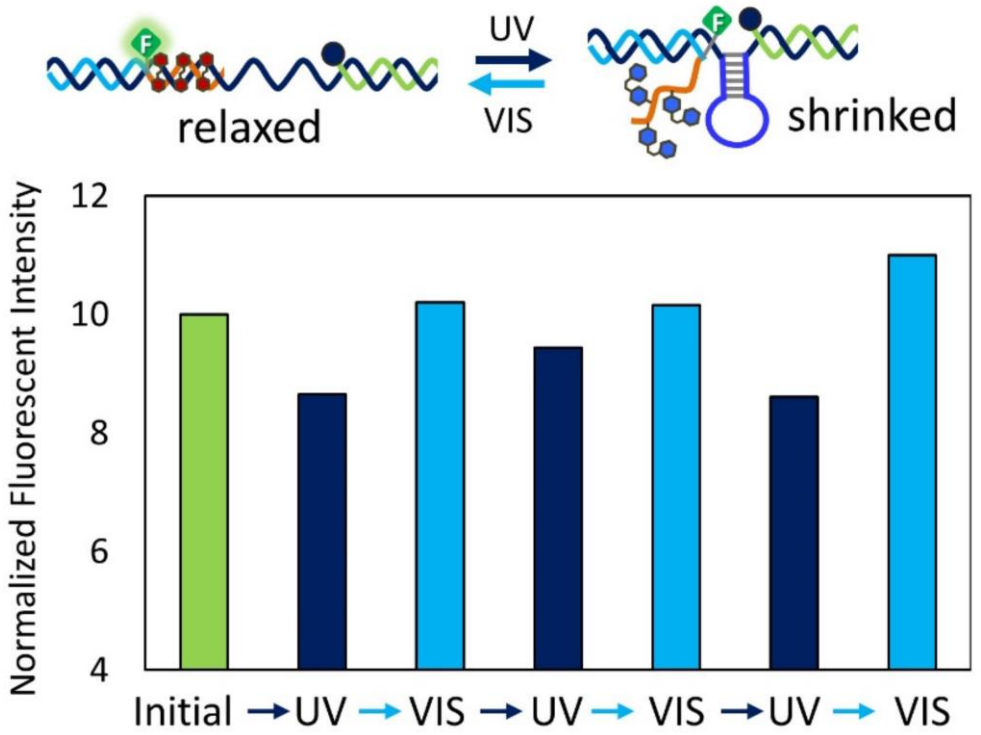




J. Am. Chem. Soc. 2017, 139, 18182−18185

Result and Discussion





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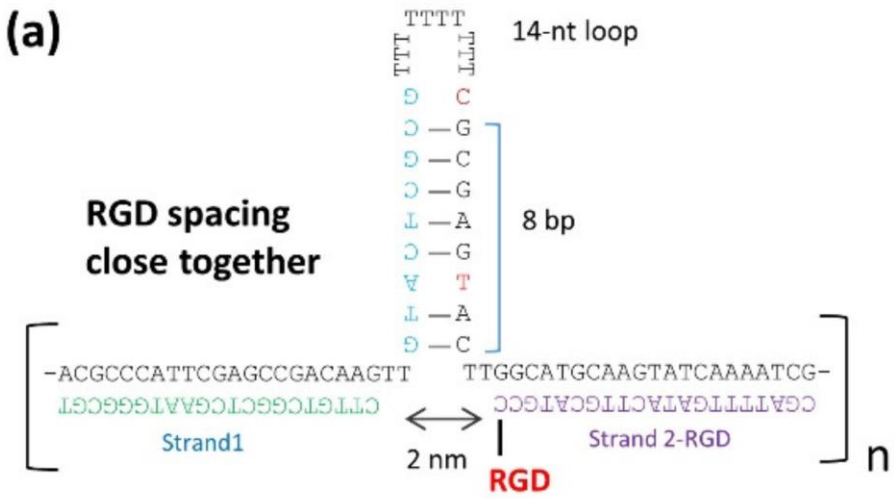

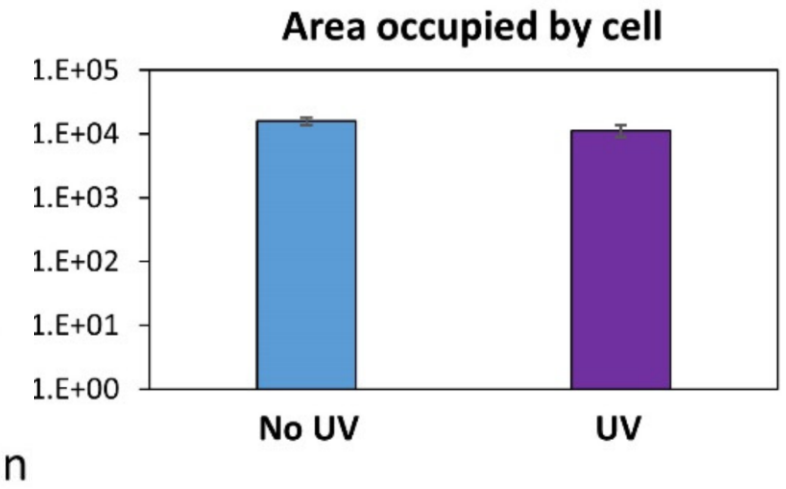

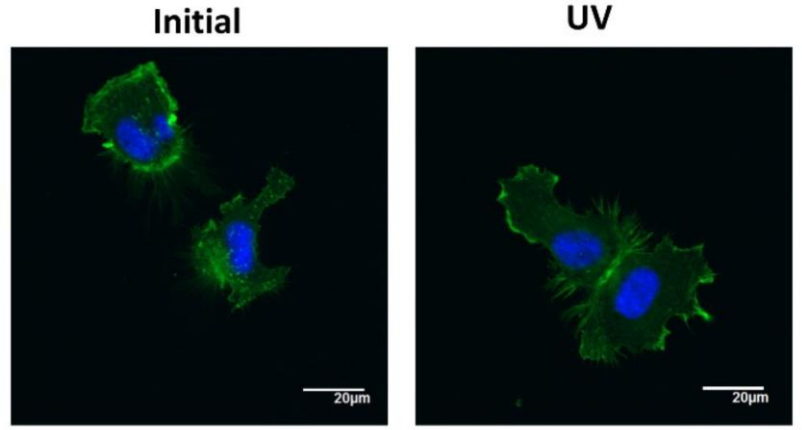

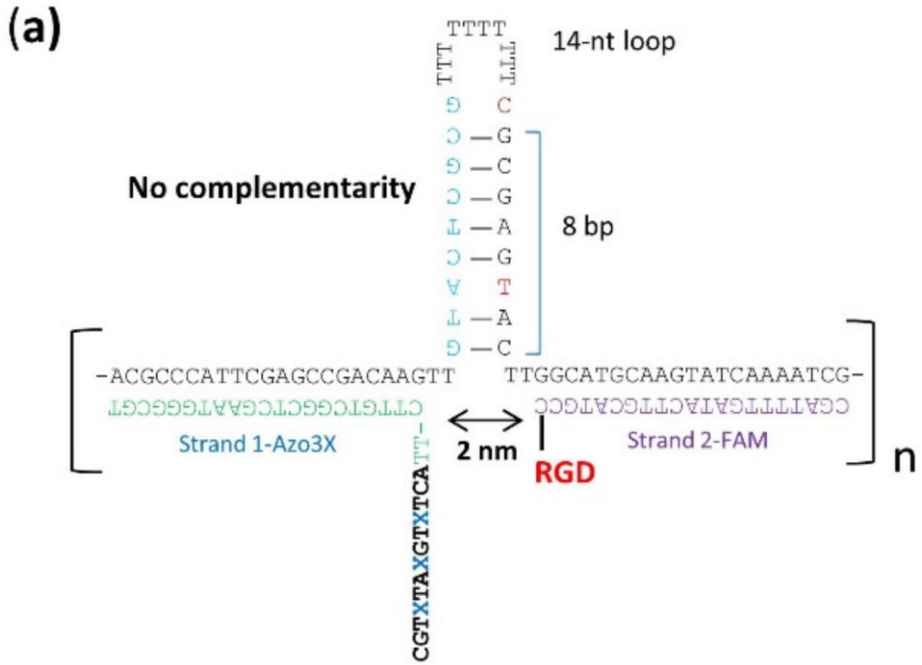

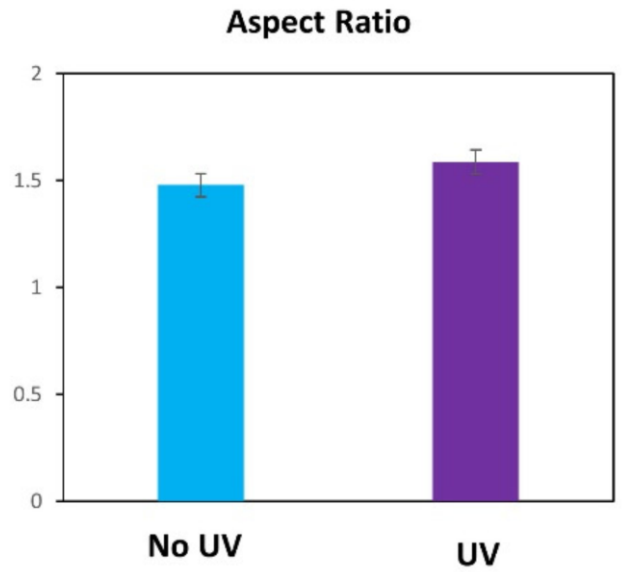

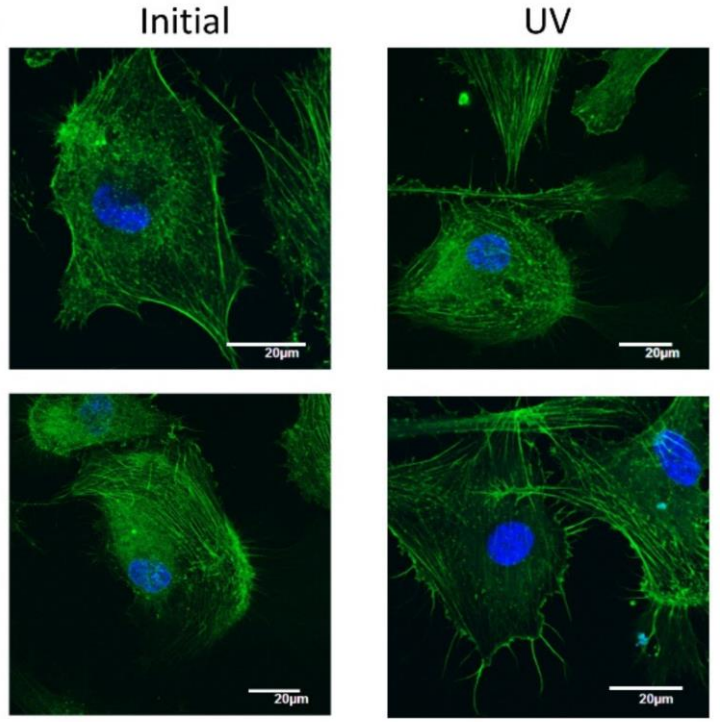

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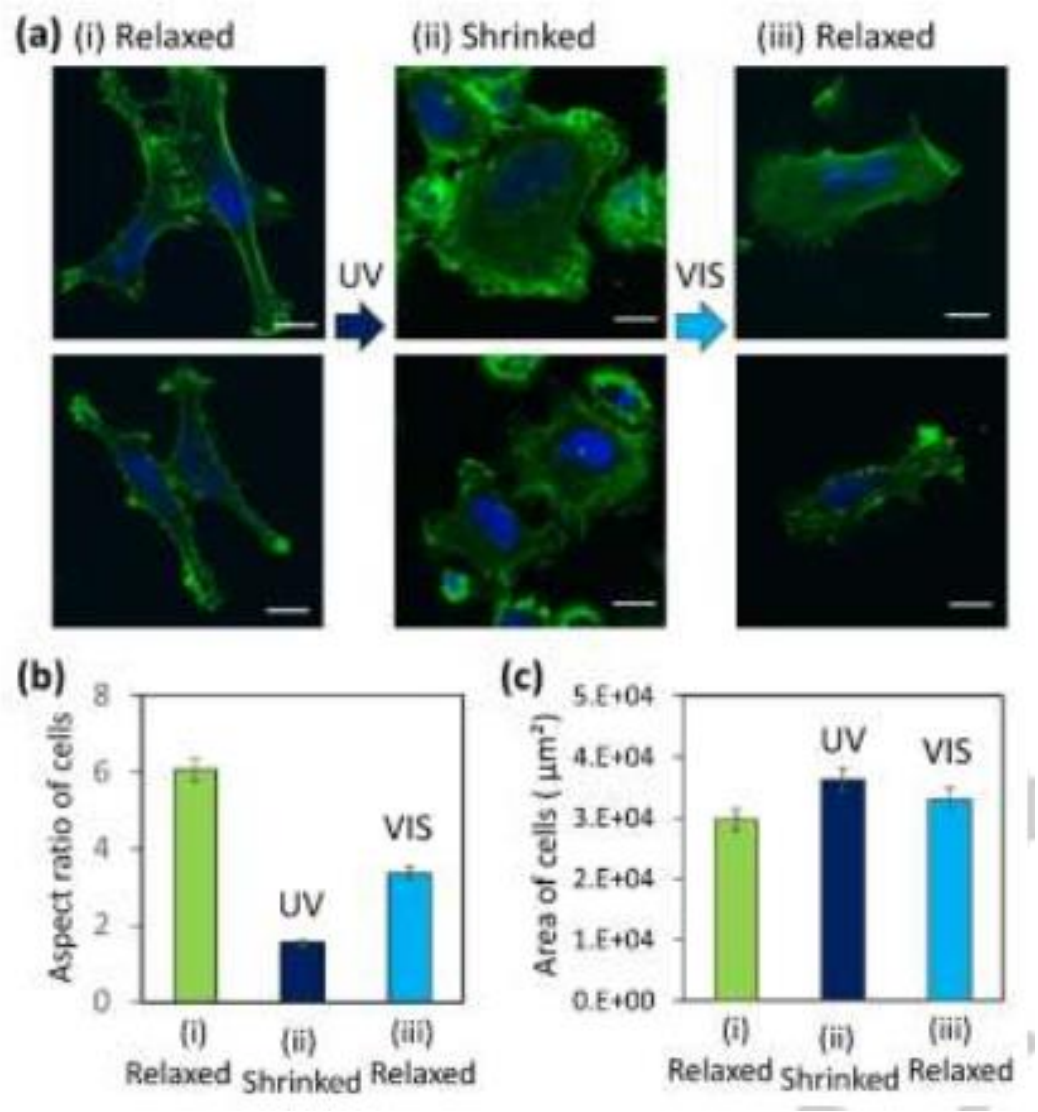

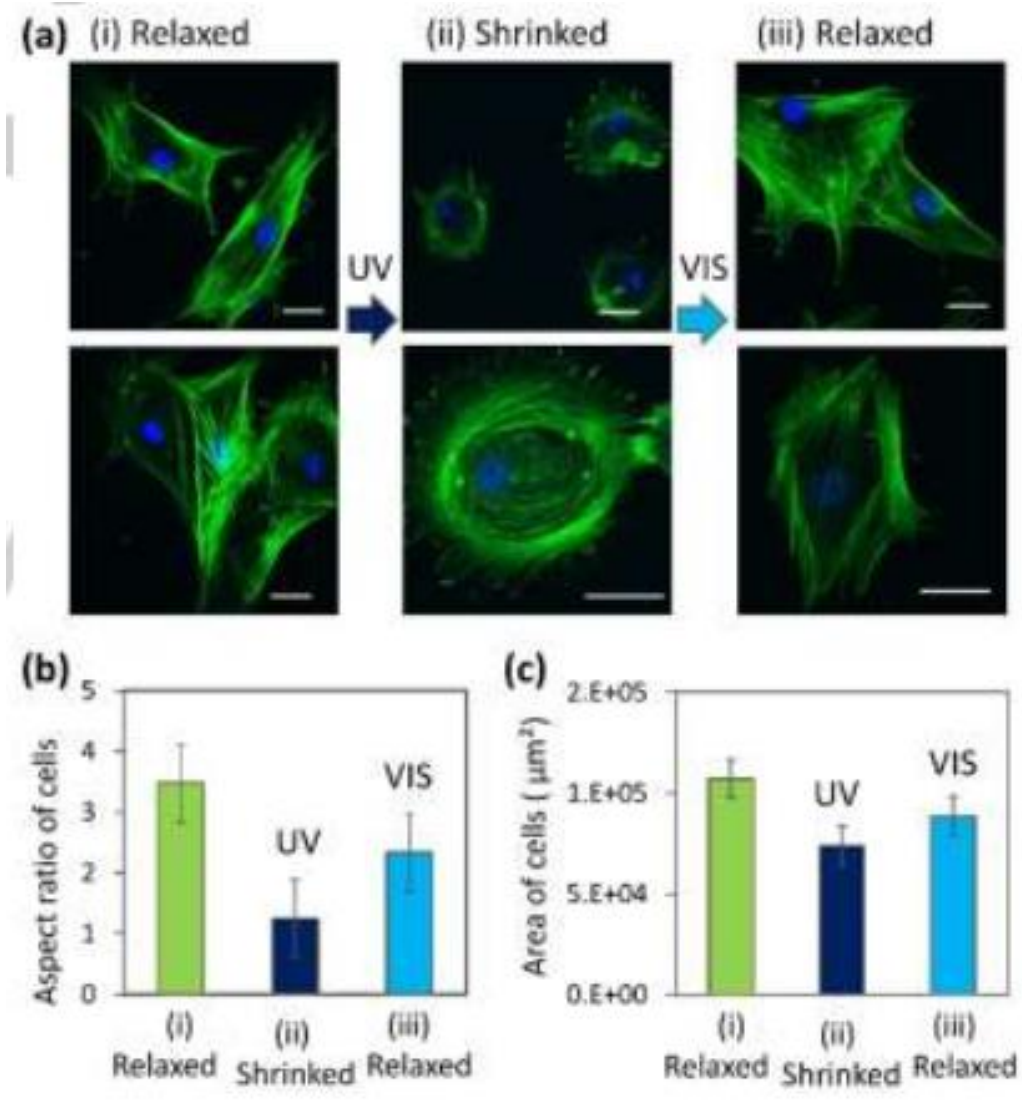

Result and Discussion

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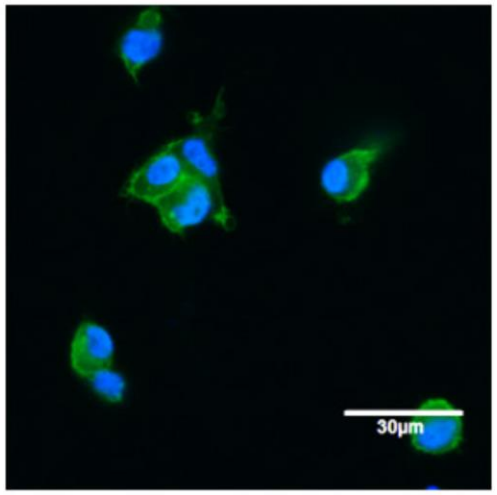
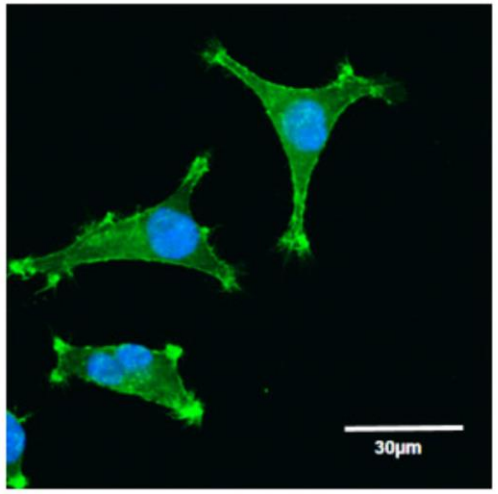
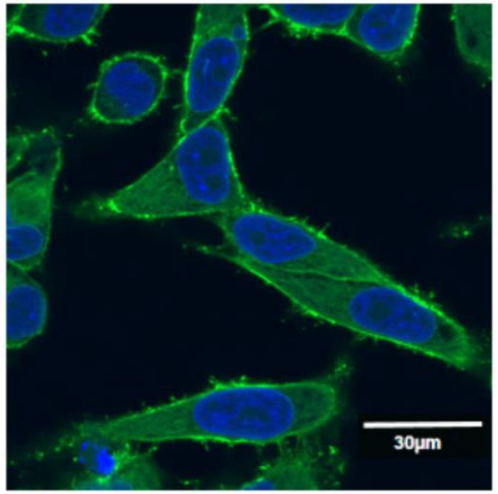


RCA only

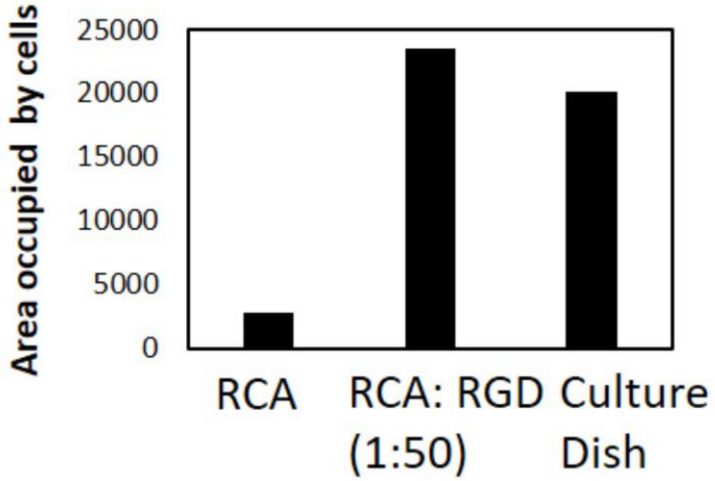


RCA: RGD (1:50)

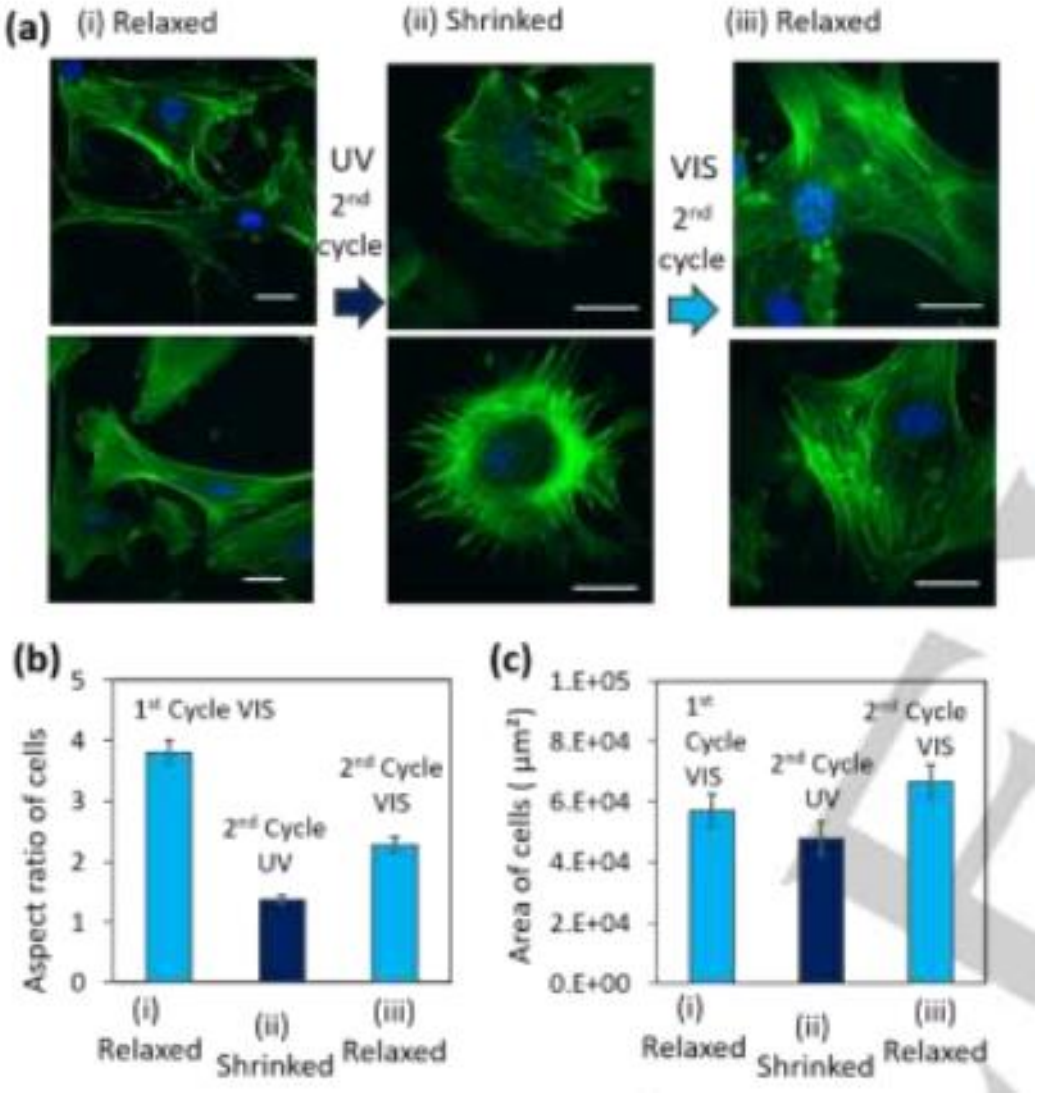


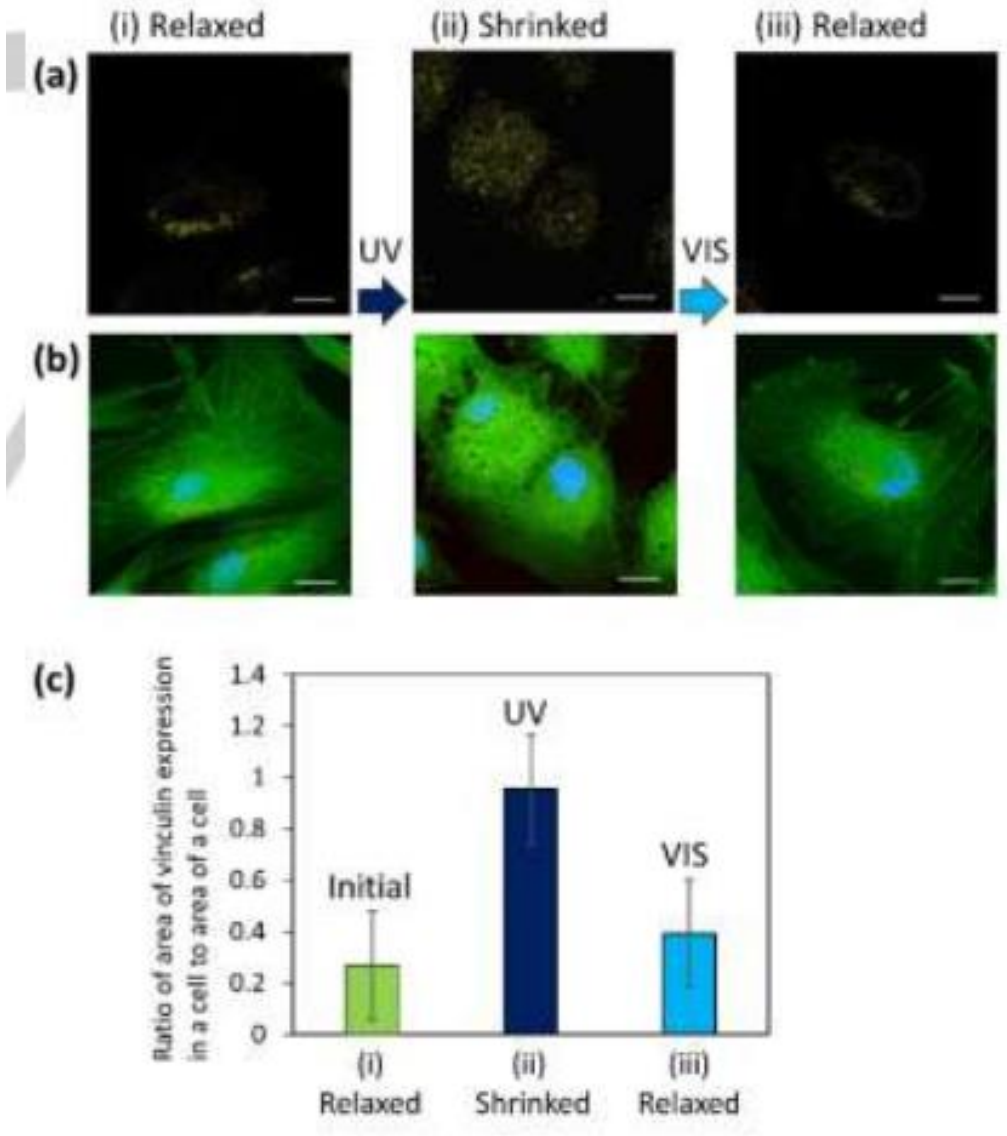
Cell culture Dish

(b)



Result and Discussion





Result and Discussion