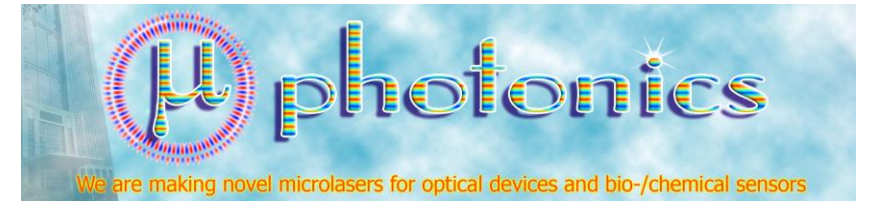




**Le Quy Don Technical University**

Department of Optical Devices



<http://microphotronics.vn>

## Smart biolasers for healthcare

**Ta Van Duong**

Le Quy Don Technical University

[duong.ta@lqdtu.edu.vn](mailto:duong.ta@lqdtu.edu.vn)

**Conference for young researchers**

25/4/2024

# Outline

1 Introduction

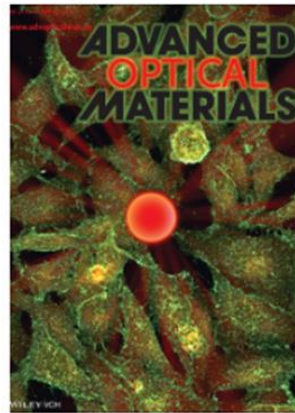
2 Laser and random lasers

3 Recent advances in biolasers for healthcare

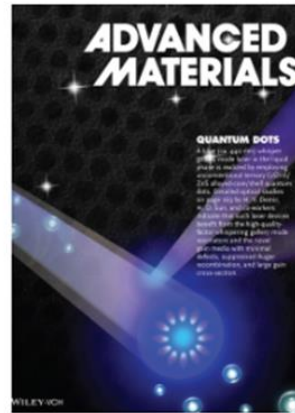
4 Our contribution to biolasers



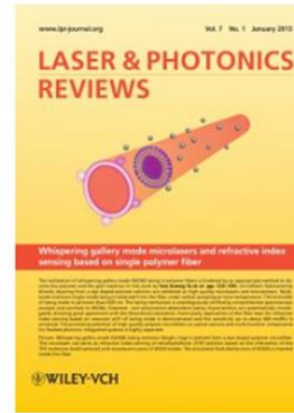
[HOMEPAGE](#) / [RESEARCH](#) / [MEMBERS](#) / [PUBLICATIONS](#) / [GALLERY](#) / [NEWS](#) / [EVENTS](#) / [JOIN US](#)



Biolasers



Quantum dot laser



Flexible lasers

## News and Announcement

- Paper accepted for publication in Soft Matter  
Congratulations to Tam Nguyen for his work entitled "Chicken albumen based whispering gallery mode microlasers" has been accepted for publication in Soft Matter.
- Paper published in Nanoscale  
Duong's paper entitled "Flexible and tensile microporous polymer fibers for wavelength-tunable random lasing" has been published in Nanoscale.
- Paper published in Optics Communications.  
Duong's paper entitled "Silica based biocompatible random lasers implantable in the skin" has been published in Optics Communications.
- Paper published in Journal of Physics D: Applied Physics  
Toan's paper entitled "Egg white based biological microlasers" has been published in Journal of Physics D: Applied Physics.
- Congratulation to Dr. Duong Ta  
Dr. Duong Ta's review paper entitled "Microlasers Enabled by Soft-Matter Technology" has been published on Advanced Optical Materials.

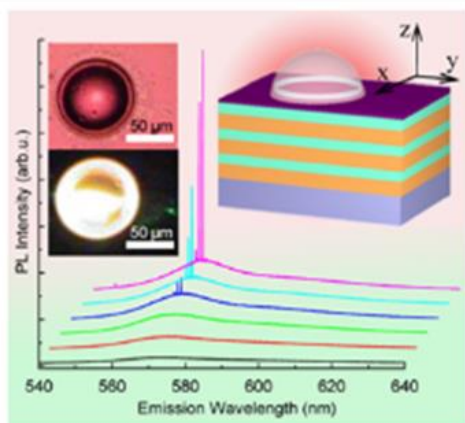
## Our sponsors



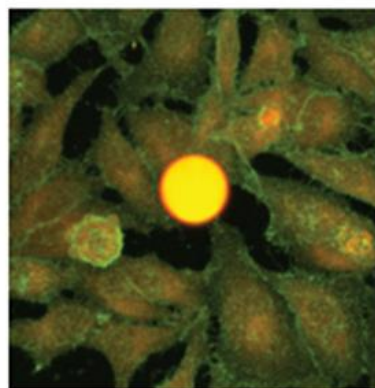
<http://microphotronics.vn/>

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EMAIL: DUONG.TA@MTA.EDU.VN

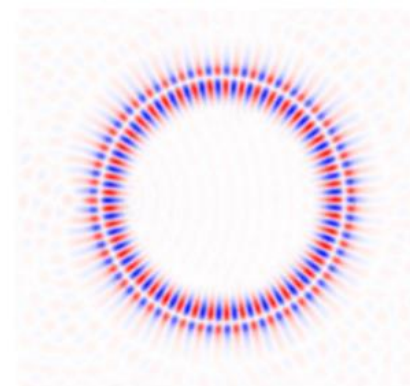
# Research interests



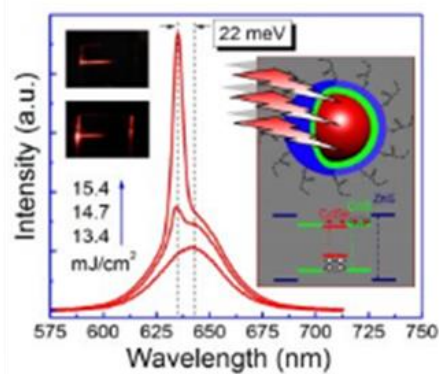
**Flexible Microlasers**



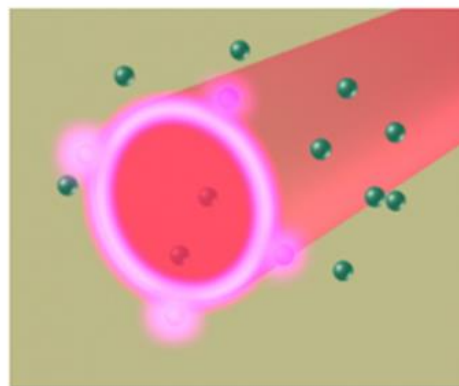
**Biolasers**



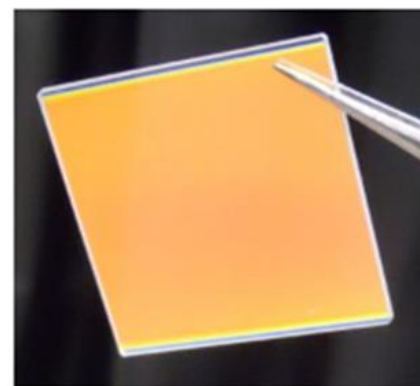
**Optical Simulations**



**Random lasing**



**Biosensing**



**Optical thin films**

# Group members



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# Professional services

**Associate  
Editor**



**ADVANCES IN NATURAL SCIENCES:  
NANOSCIENCE AND NANOTECHNOLOGY**

**Reviewers**

**Advanced Functional Materials**

**Advanced Optical Materials**

**Optica**

**Nanophotonics**

**Photonics Research**

**Advanced Photonics**

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**Optical Engineering**

**ACS sensors**

**ACS Applied Nano Materials**

**Analytical Chemistry**

**Scientific Reports**

**Sensors and Actuators B**

**Applied Surface Science**

**Surface and Coatings Technology**

.....

# Happiest moments at Vietnam School of Science



**Rencontres du Vietnam**  
VIETNAM SCHOOL OF SCIENCE 8<sup>th</sup> 2020: DRIVING CHANGES

THỜI GIAN: 28/11, 29/11, 30/11, 1/12 NĂM 2020 ĐỊA ĐIỂM: ICISE, GHỀNH RẰNG, TP. QUY NHƠN, TỈNH BÌNH ĐỊNH

TRƯỜNG KHOA HỌC VIỆT NAM 8  
LẦN THỨ 8, ICISE, QUY NHƠN, 28/11-1/12 NĂM 2020

**180**  
học viên

**4**  
ngày

vượt lên biển động

**NỘI DUNG**

**DRIVING CHANGES** **NEW**

**Covid-19**  
**Climate change**  
**Quantum computing**  
**Artificial intelligence**  
**Nature reservation**

**GIẢNG VIÊN**

- TS. Nguyễn Ngọc Anh, University of Lancaster (Anh) / DEPOCEN
- TS. Giáp Văn Dương – Technical University Wien (Áo) / GiápGroup
- TS. Trần Trọng Dương – Viện Hàn lâm Khoa học Xã hội Việt Nam
- TS. Tạ Văn Dương – Nanyang Technological University (Sing) / DHLQD
- TS. Nguyễn Xuân Hoài – UNSW (Úc) / AI Academy
- TS. Nguyễn Bảo Huy – University of Sherbrooke (Canada) / ĐHBKHN
- TS. Nguyễn Ngọc Huy – Kyoto University (Nhật) / UNESCO
- TS. Nguyễn Tô Lan – Viện Hàn lâm Khoa học Xã hội Việt Nam
- TS. Đỗ Văn Nam – Paris-Sud University (Pháp) / ĐH Phenikaa
- TS. Lê Thị Tuyết Nhung – Marseille University (Pháp)
- TS. Đặng Văn Sơn – University of Birmingham (Anh) / ĐHQGHN
- TS. Nguyễn Thu Trang – University of Cambridge (Anh) / WikAct
- ThS. Nguyễn Phương Nghi – University of Cambridge (Anh) / ĐHQGTPHCM

**TỔ CHỨC**  
Ban cố vấn



1 Introduction

2 Laser and random lasers

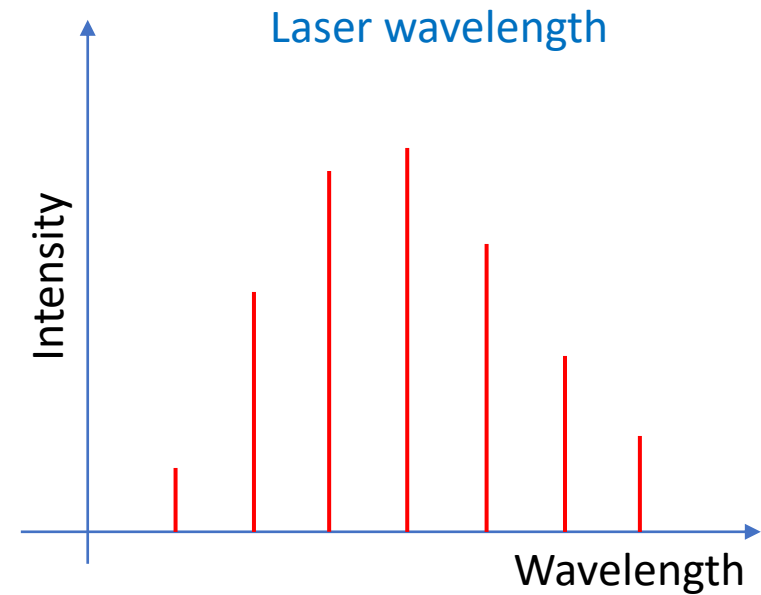
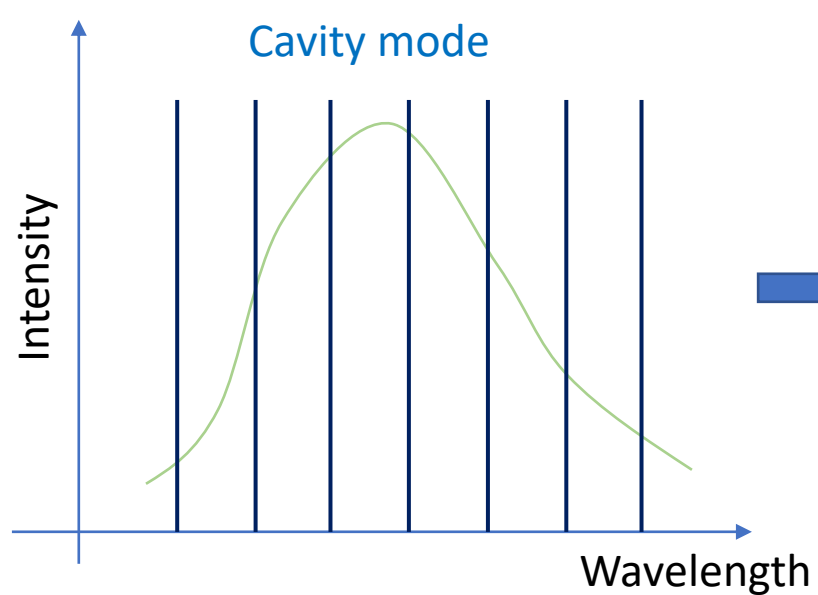
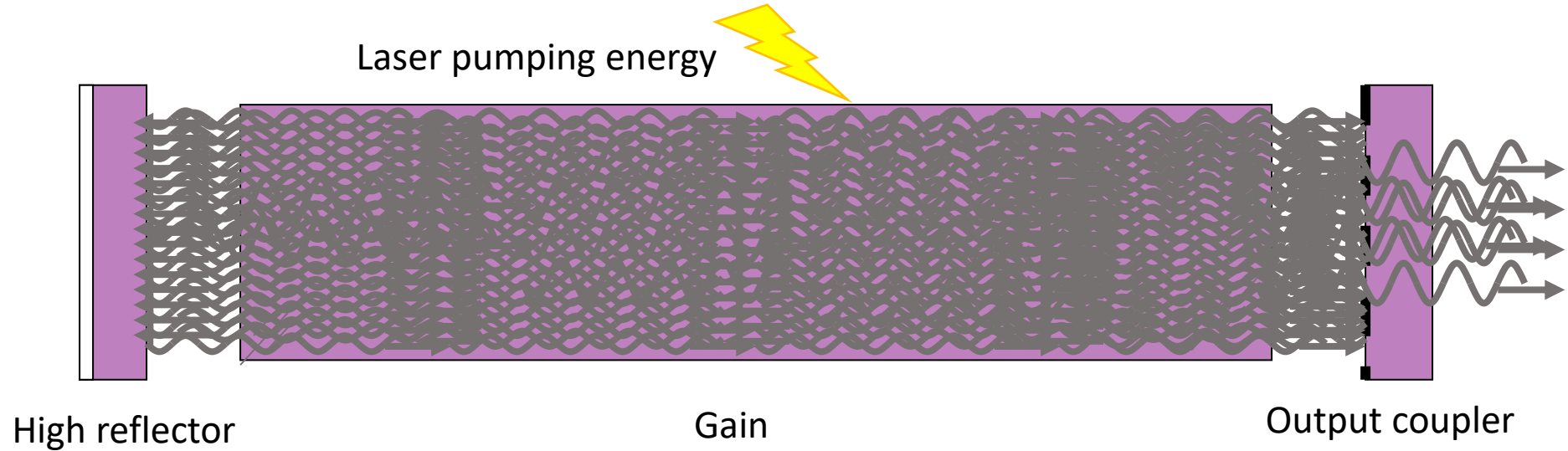
3 Recent advances in biolasers for healthcare

4 Our contribution to biolasers

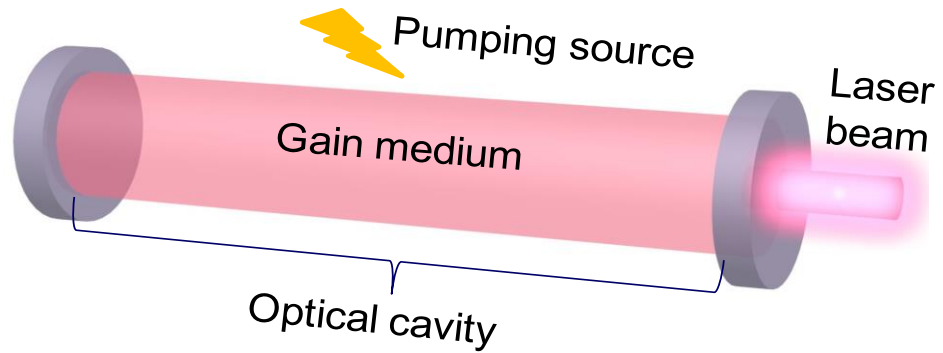


# How does a laser work?

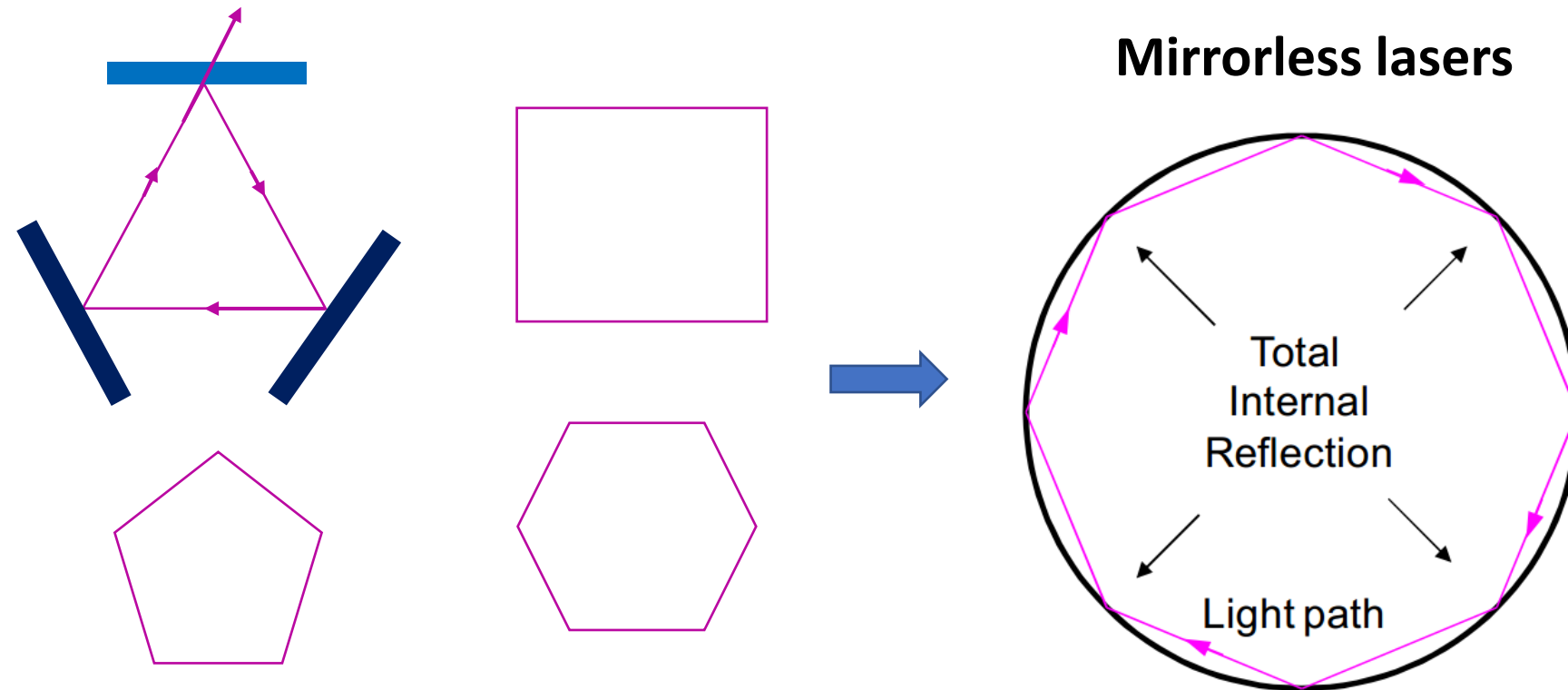
LASER (**l**ight **a**mplification by **s**timulated **e**mission of **r**adiation)



# Microsphere lasers



## Mirrorless lasers

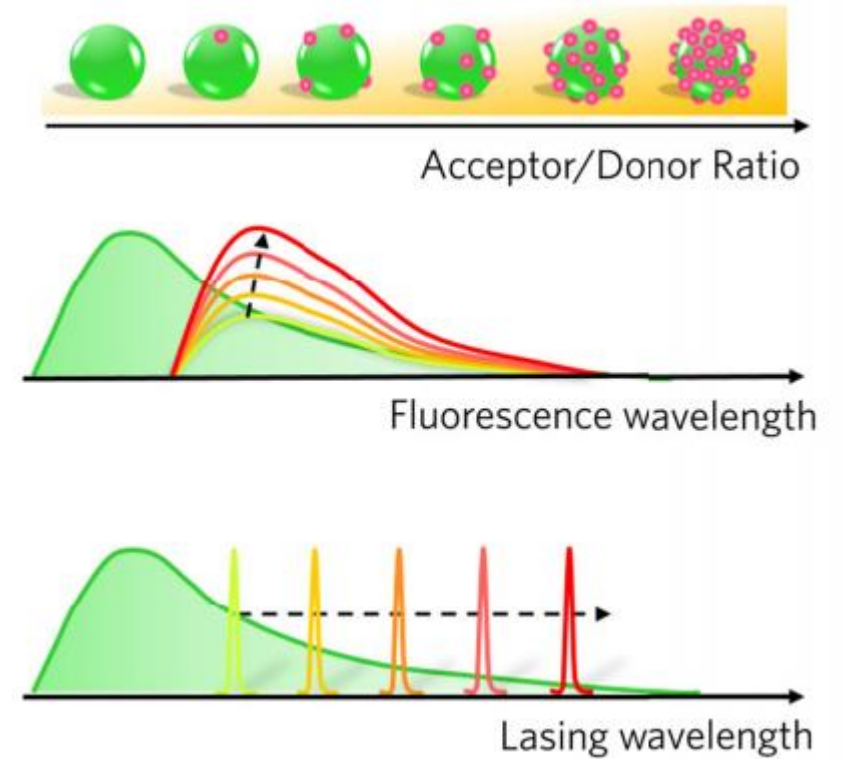
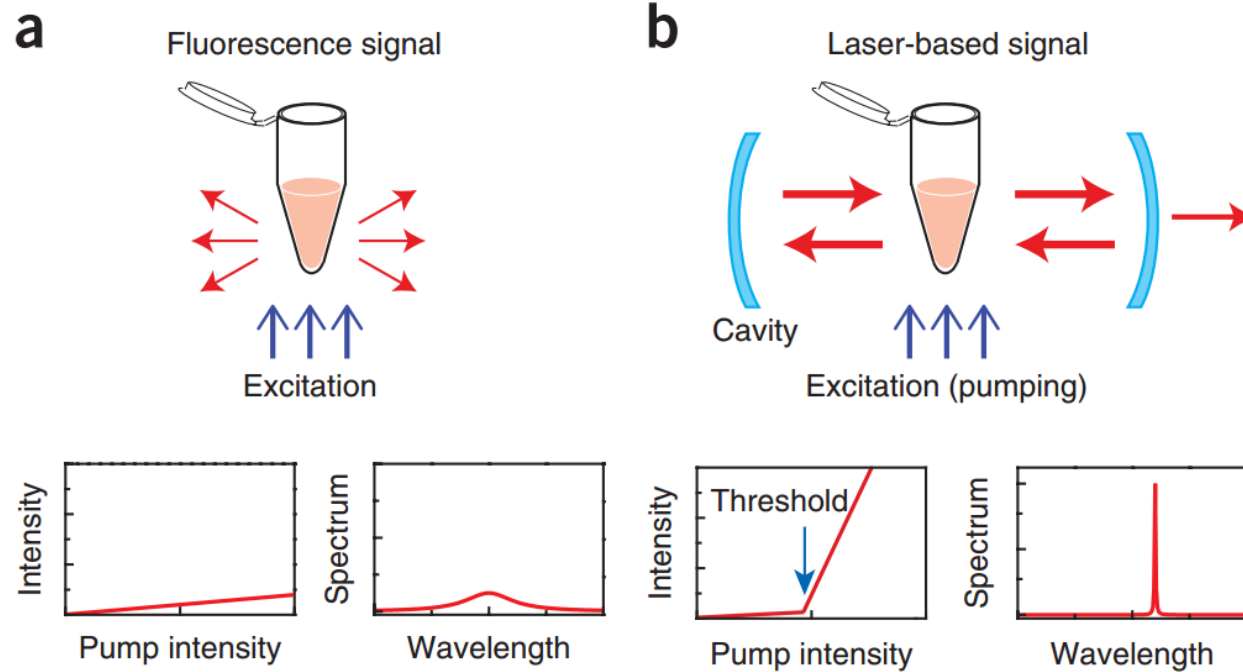


V. D. Ta, *et al.*, *Appl. Phys. Lett.* **107**, 221103 (2015)

# Why biolasers are great?

1. Environment-friendly
2. Biocompatibility----Implantable optical devices.
3. Sensitive way to measure changes in biological molecules/internal cells, tissues

## Laser enhances sensitivity



X. Fan, S.-H. Yun, *Nat. Methods* **11**, 141 (2014).

Yuan, Z. *et al.* in CLEO conference, ATH3K.1

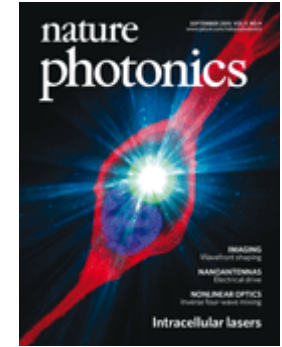
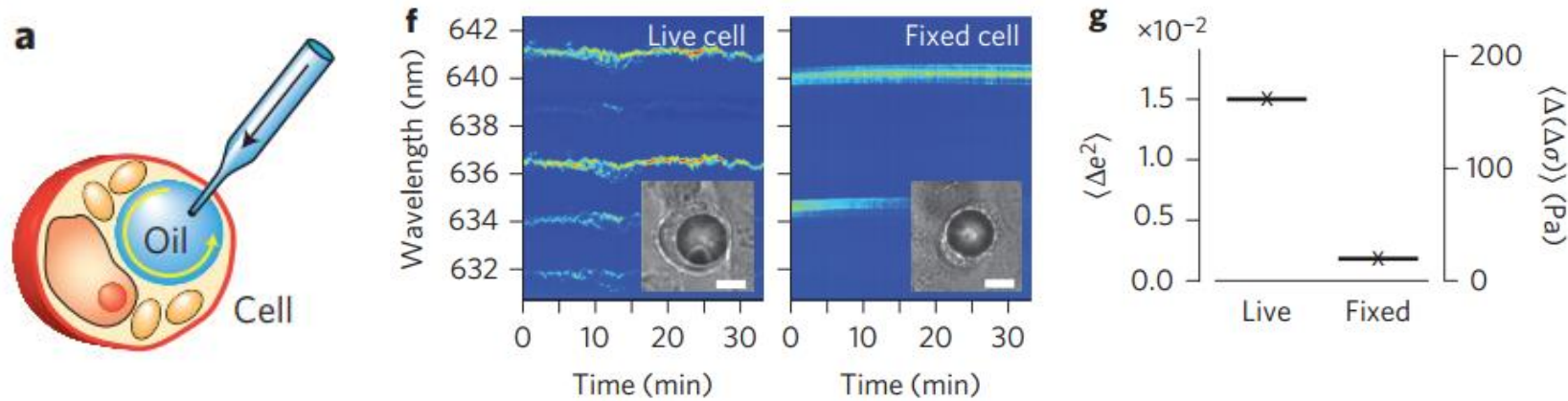
1 Introduction

2 Laser and random lasers

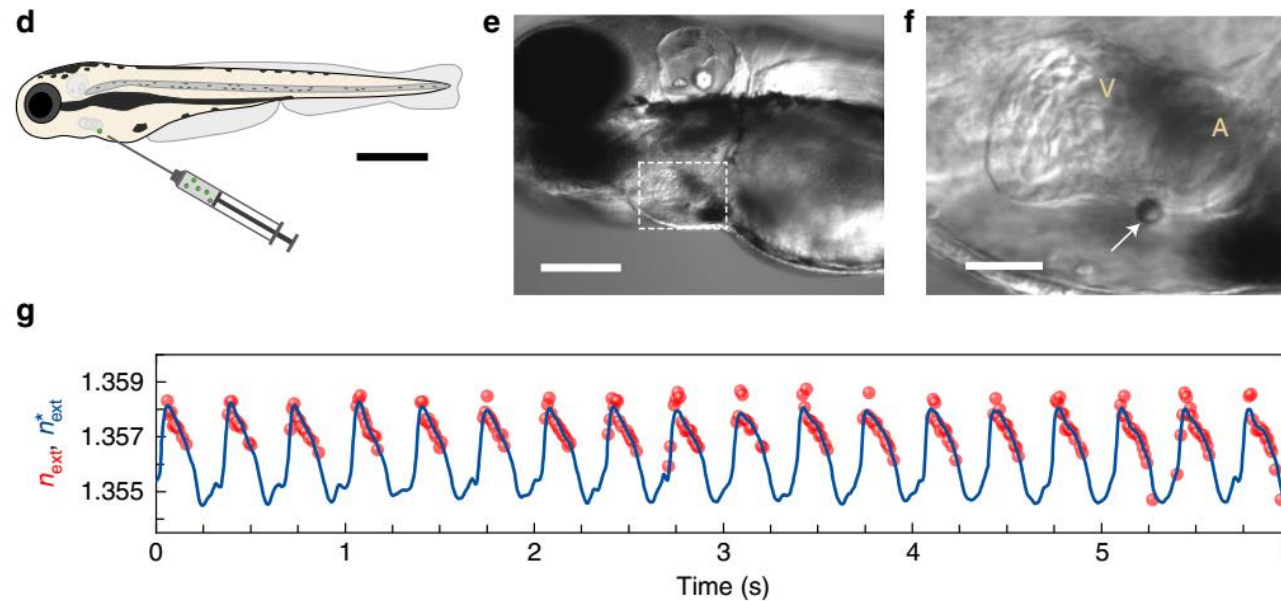
3 Recent advances in biolasers for healthcare

4 Our contribution to biolasers

# Biolasers for intracellular sensors

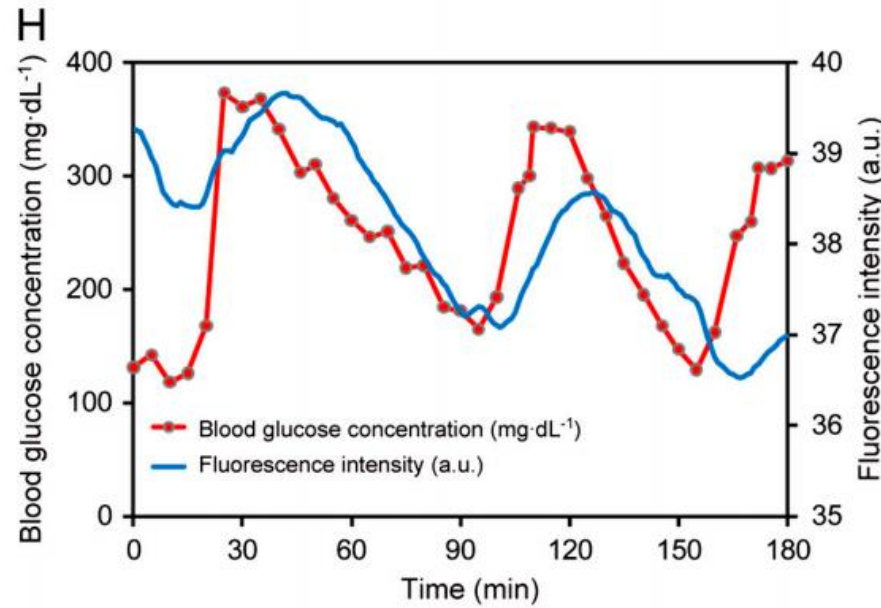
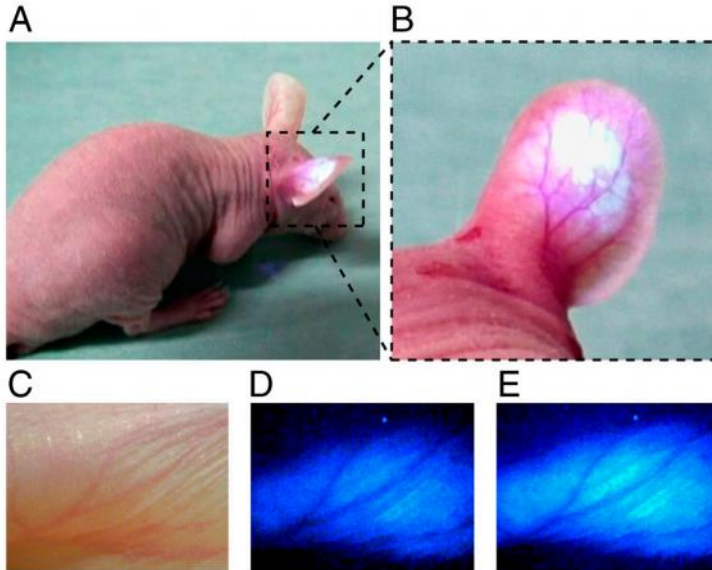
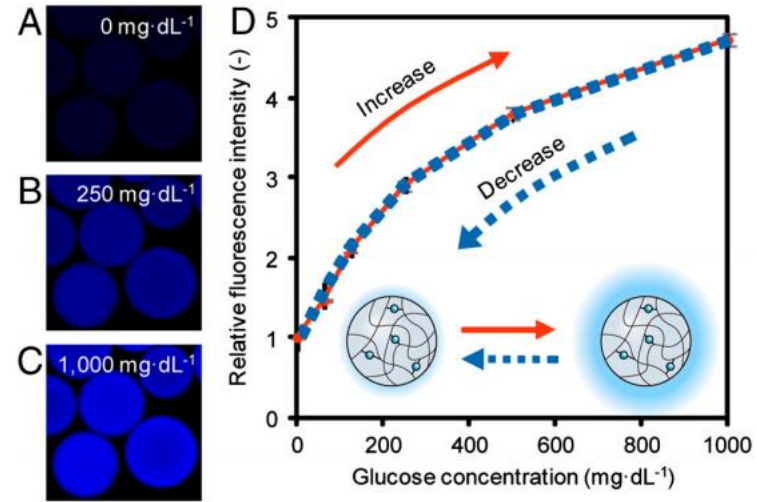


Humar, M. & Hyun Yun, S.  
*Nat. Photon.* **9**, 572-576 (2015)



Schubert, M. *et al.*  
*Nat. Photon.* **14**, 452-458 (2020)

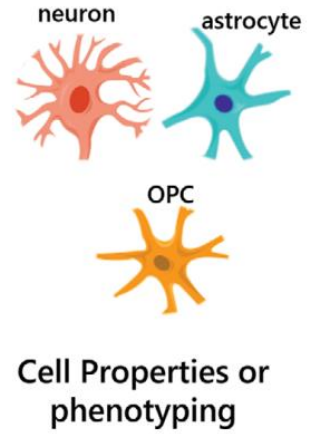
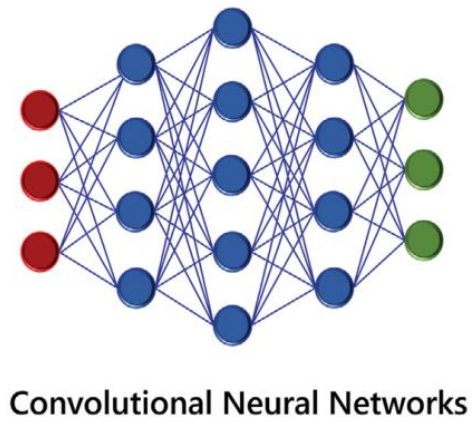
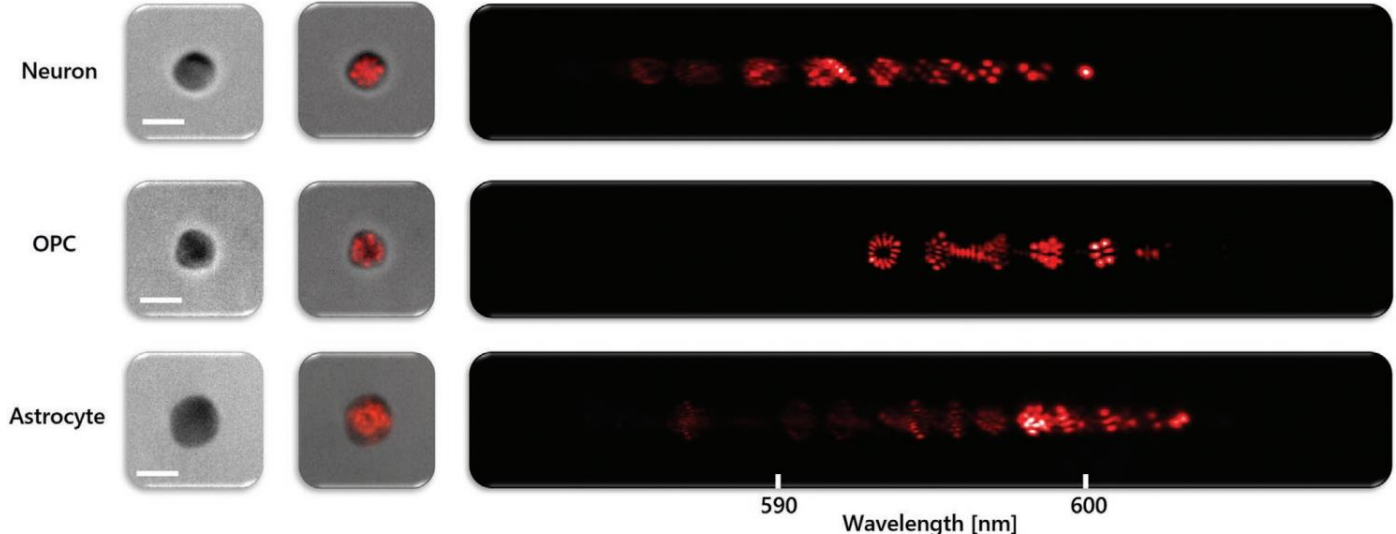
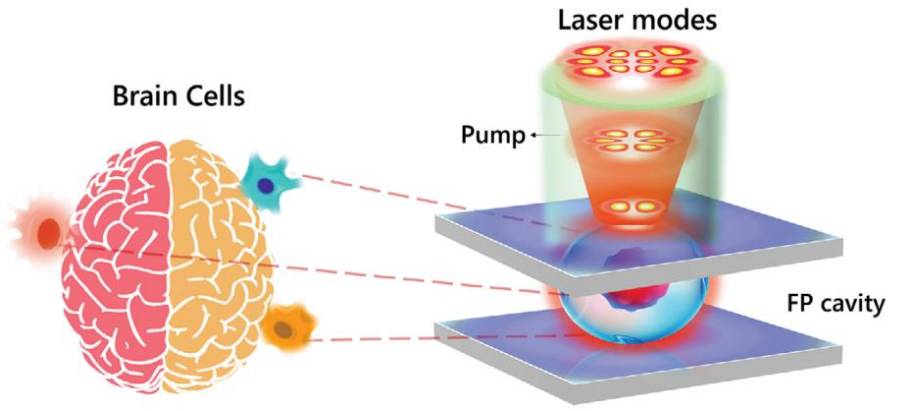
# Glucose sensing



Northeastern University

# Biolasers with AI

a

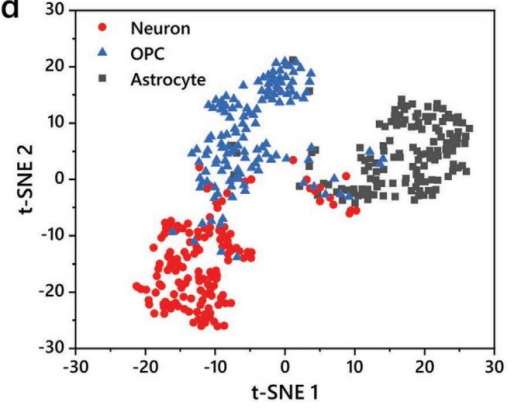


c

	Neuron	OPC	Astrocyte
Neuron	89.3% (125)	6.4% (9)	4.3% (6)
OPC	6.7% (9)	88.1% (119)	5.2% (7)
Astrocyte	0.7% (1)	7.3% (10)	92.0% (127)
	Neuron	OPC	Astrocyte
	Prediction		

100%  
0%

d



1 Introduction

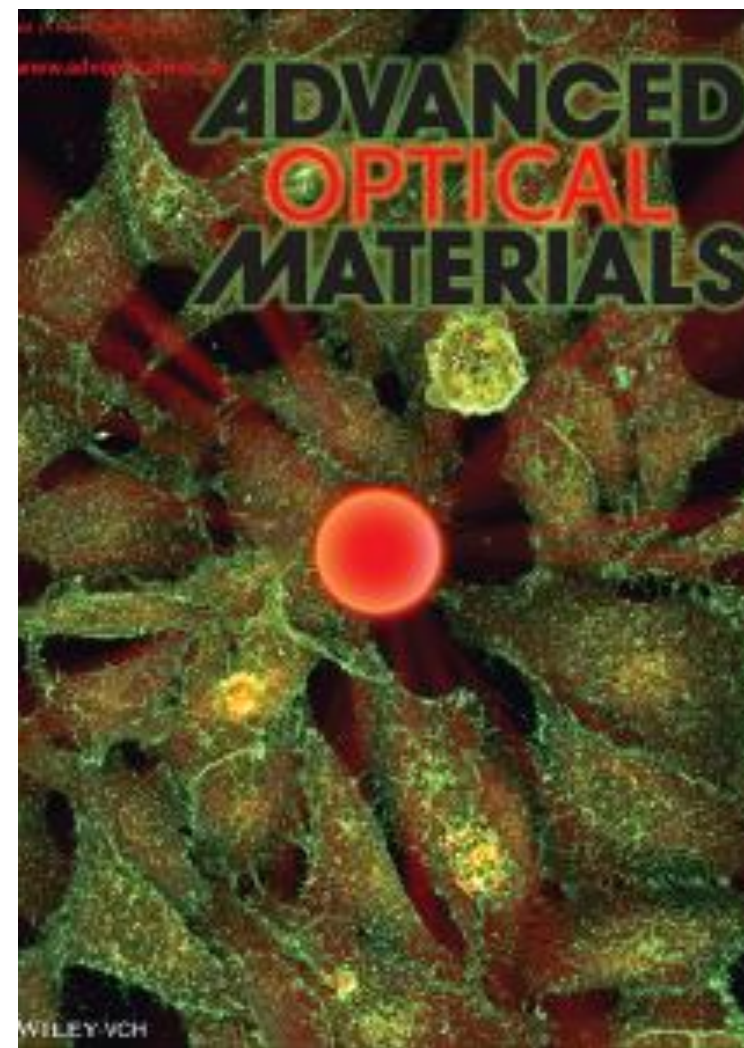
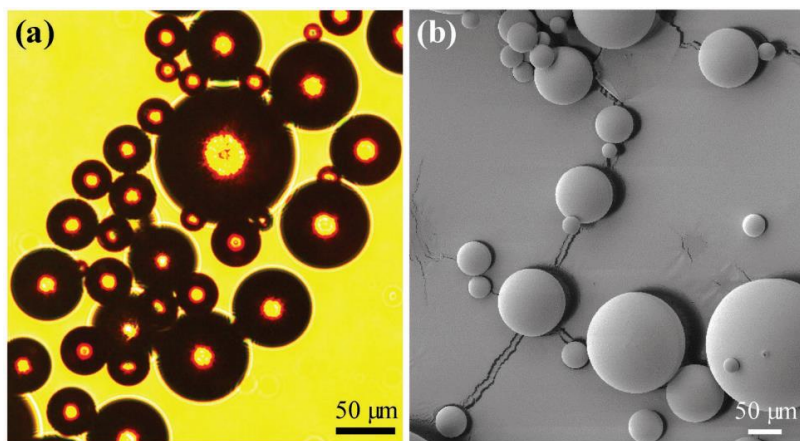
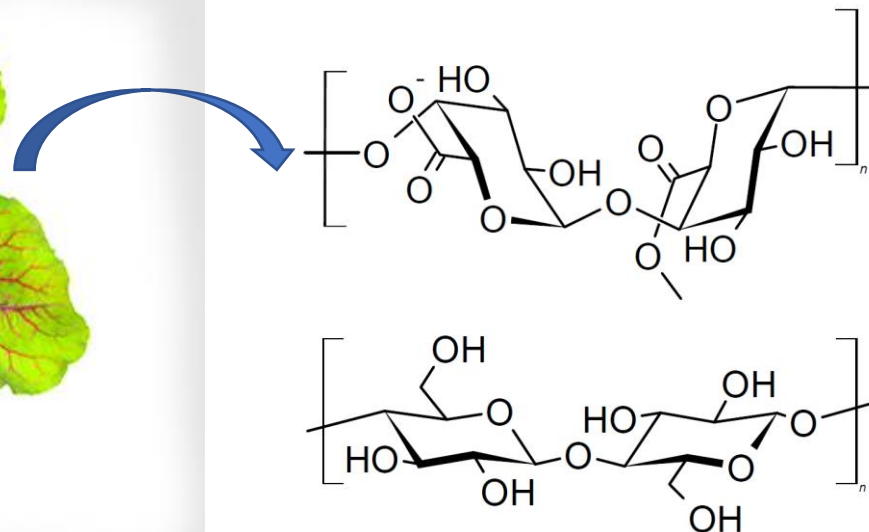
2 Laser and random lasers

3 Recent advances in biolasers for healthcare

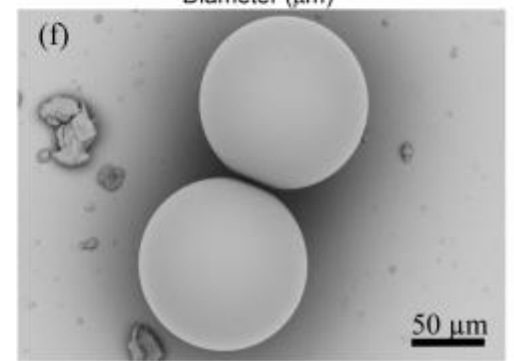
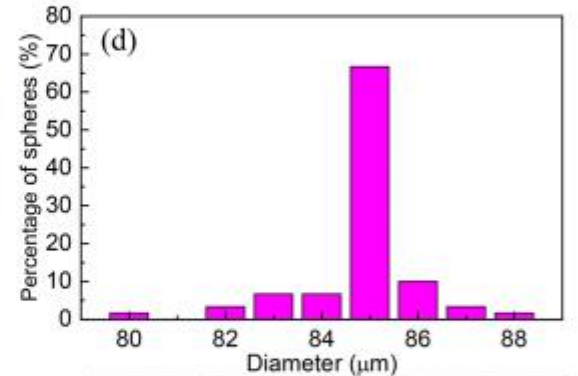
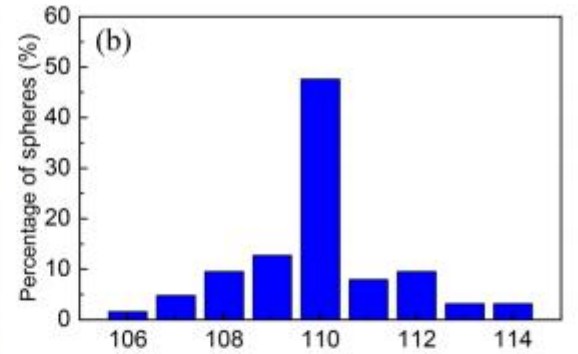
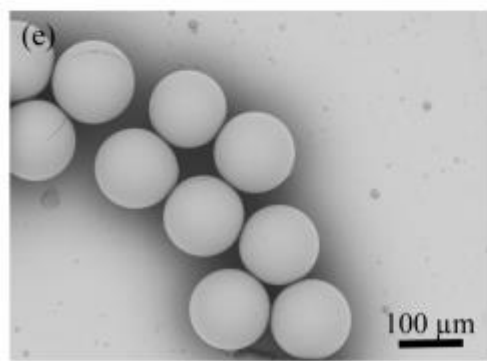
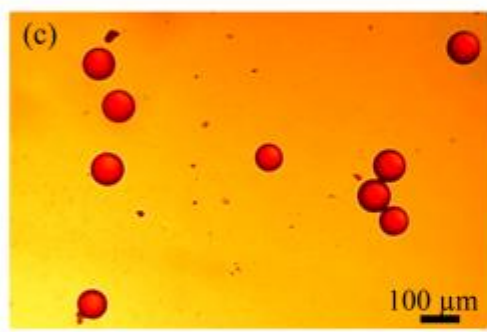
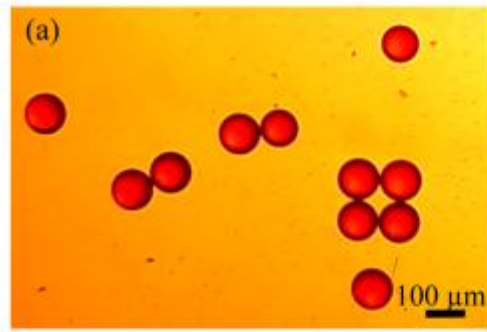
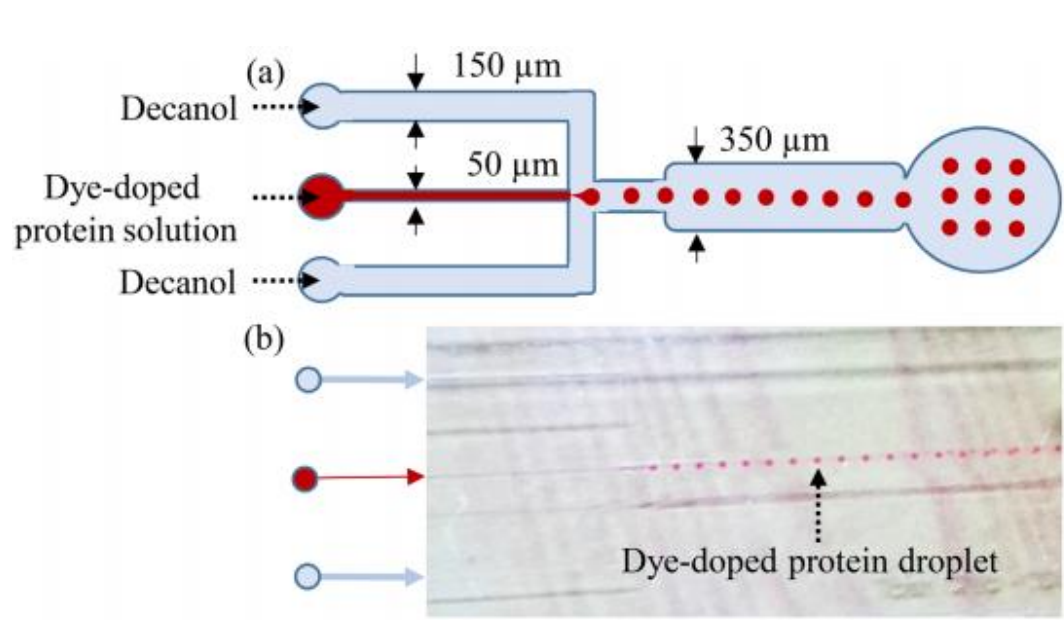
4 Our contribution to biolasers



# Biolasers from biomaterials



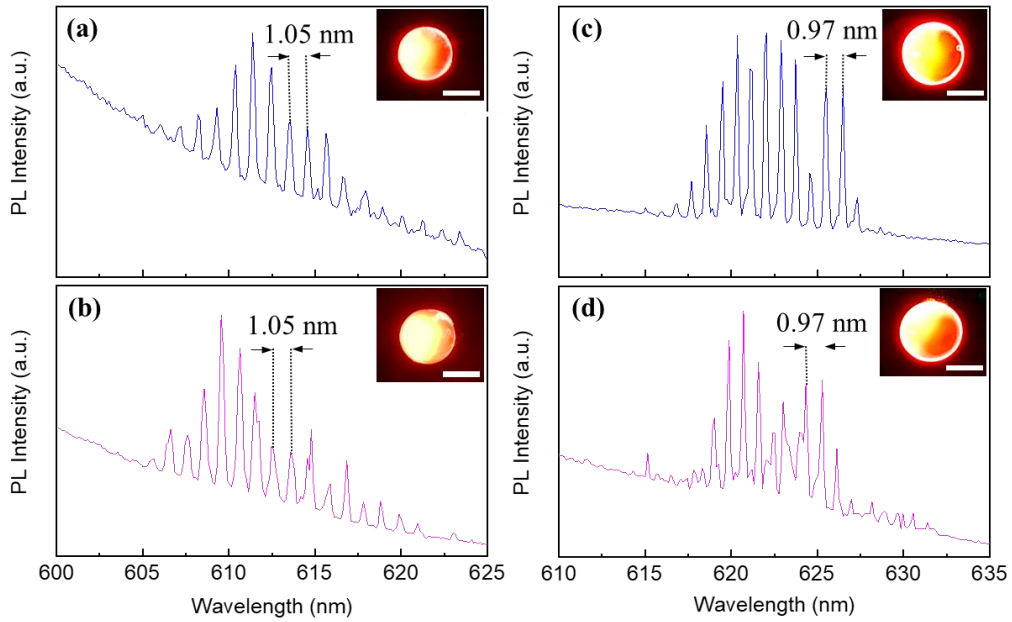
# Uniform and tunable size



# Biolasers as sensitive sensors

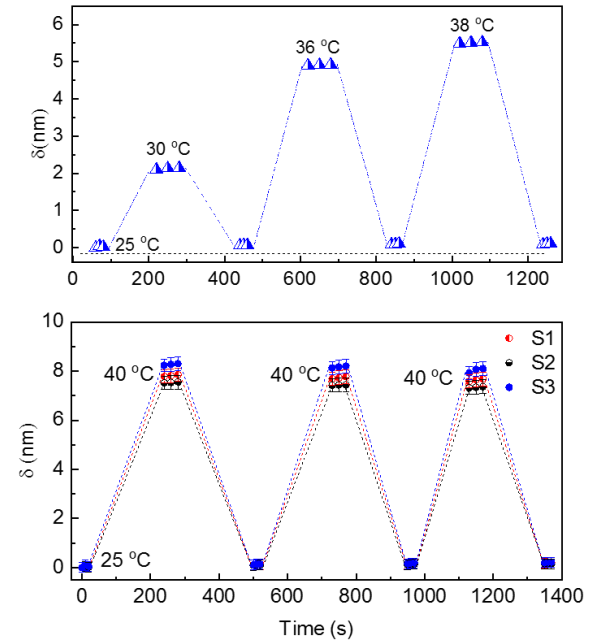
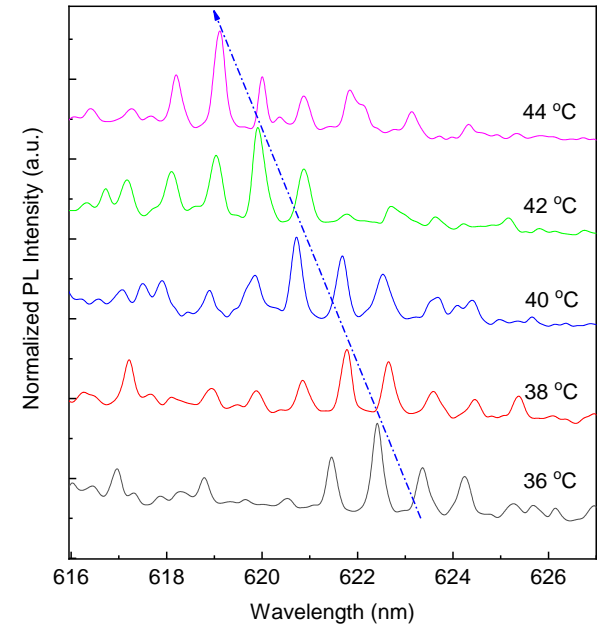
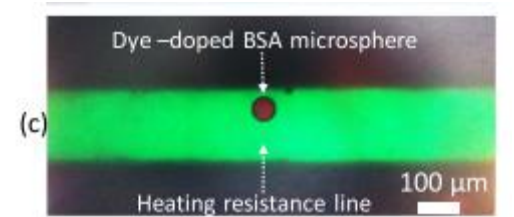
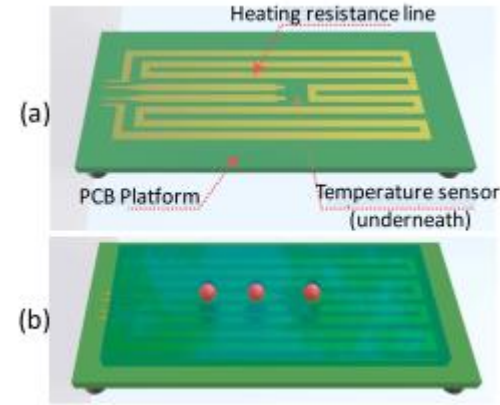
76  $\mu\text{m}$

85  $\mu\text{m}$



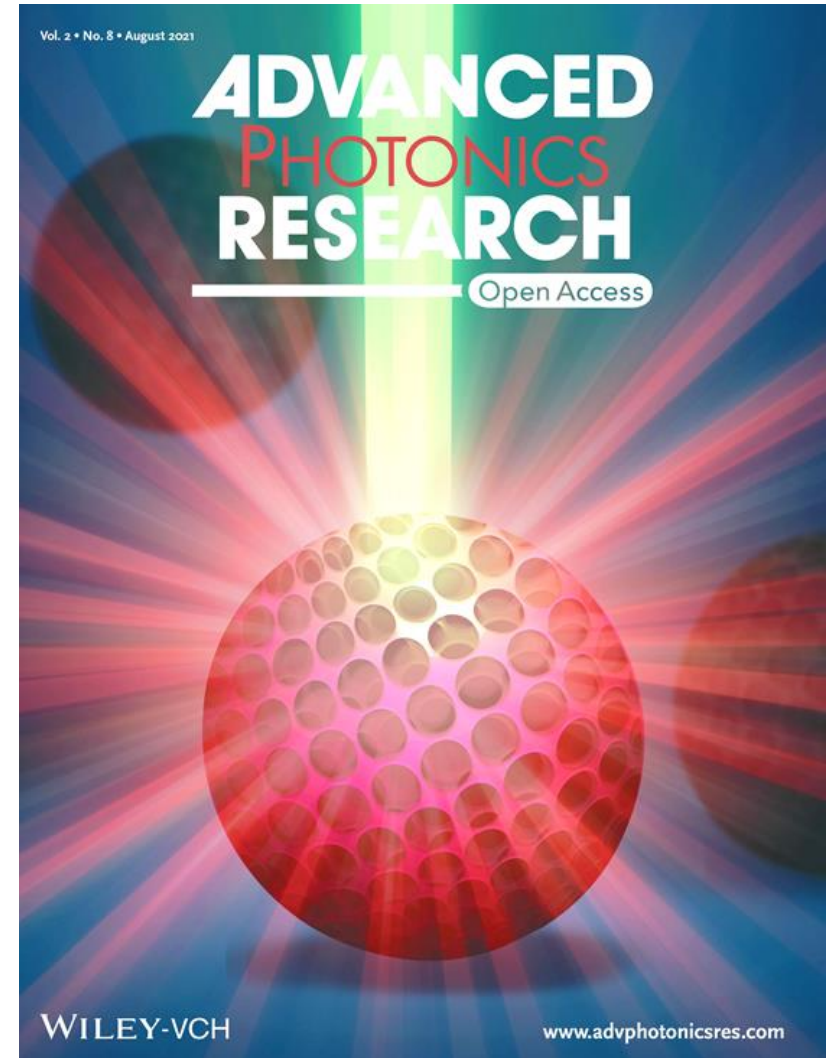
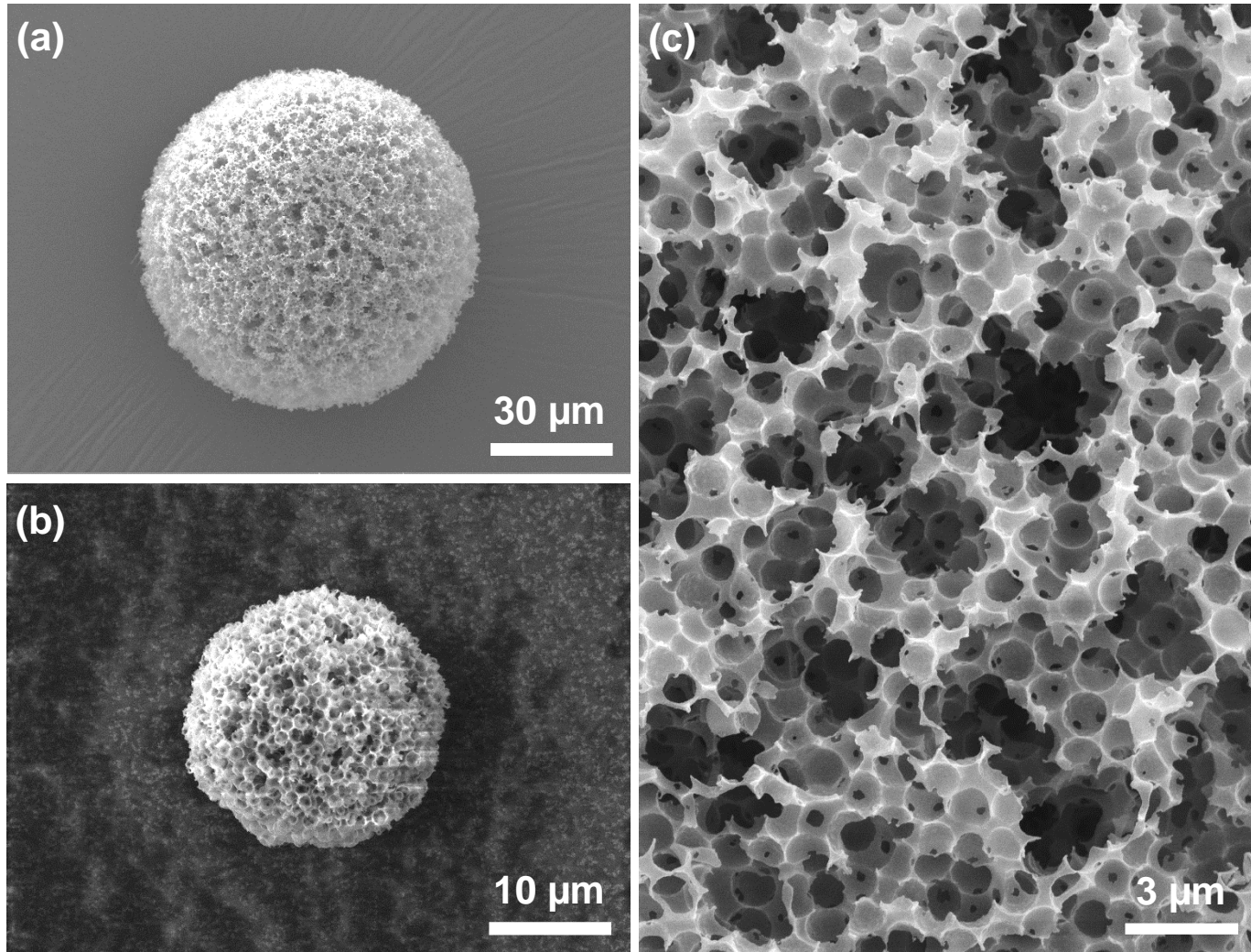
All scale bars are 50  $\mu\text{m}$

Nguyen, T. V. *et al. Opt. Lett.* 46, 2517-2520 (2021)

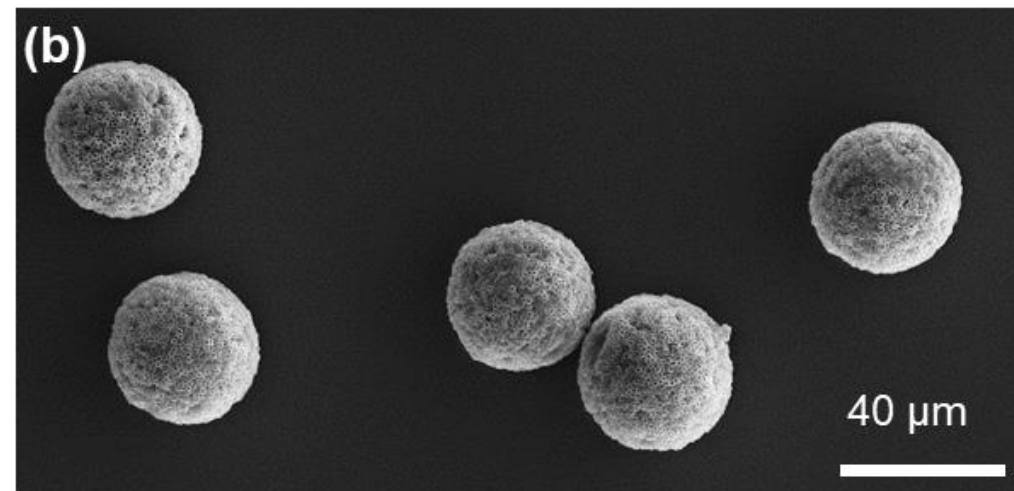
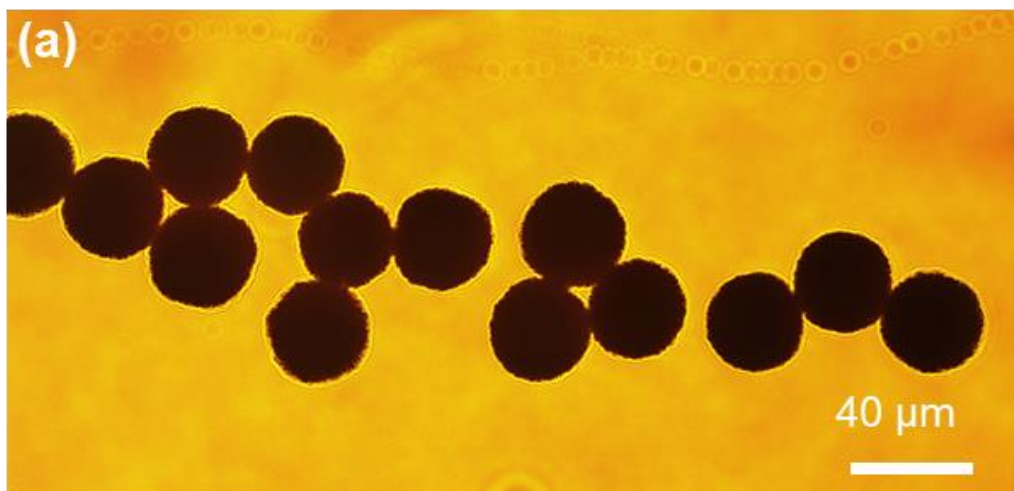
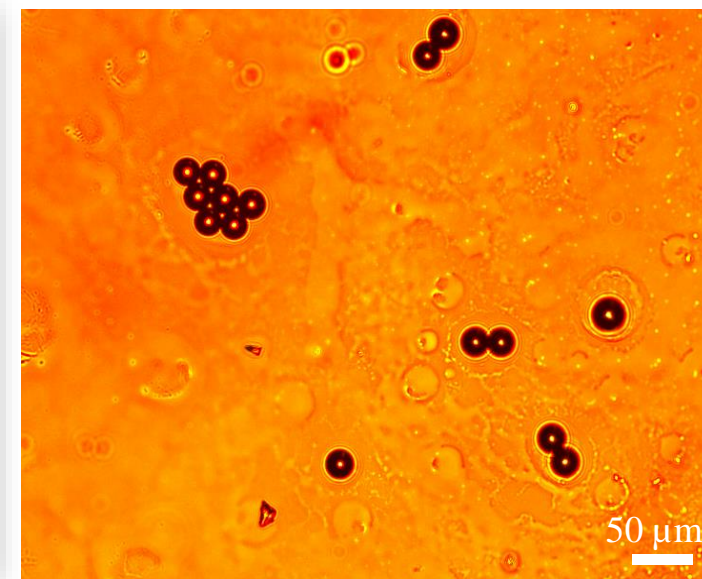
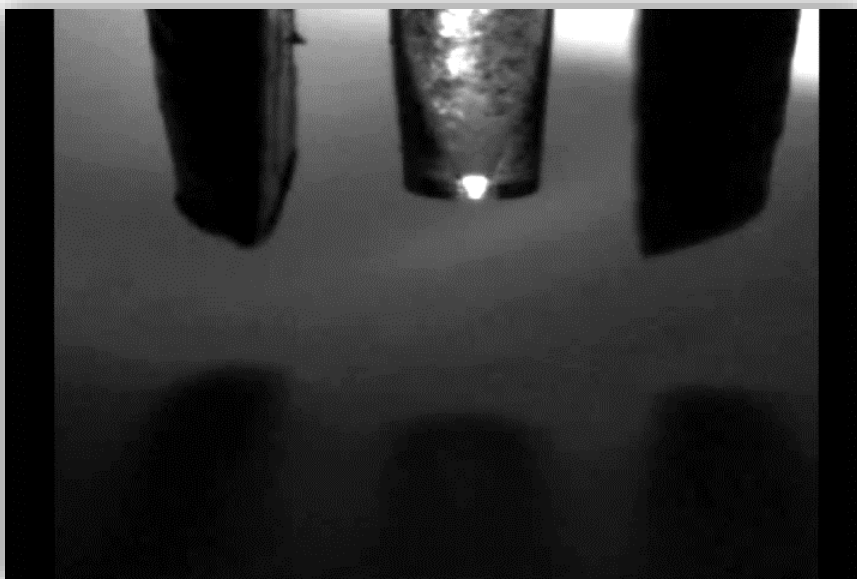


Nguyen, T. V. *et al. J. Phys. D: Appl. Phys.* 55, 405402 (2022)

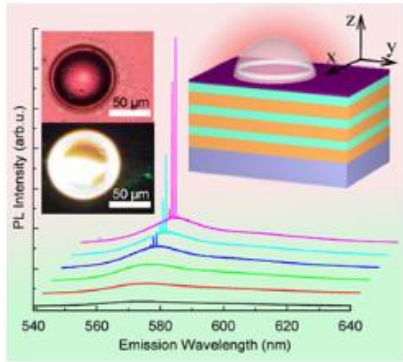
# Random microlasers



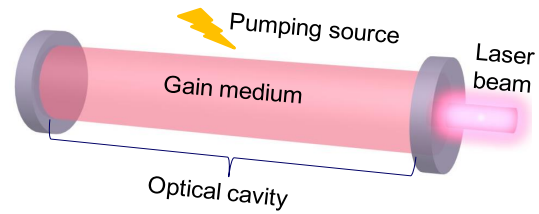
# Uniform and tunable microlasers



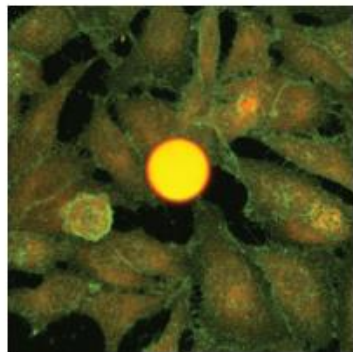
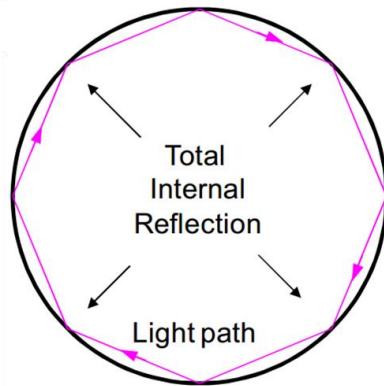
# Summary



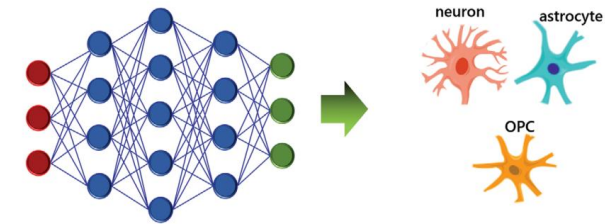
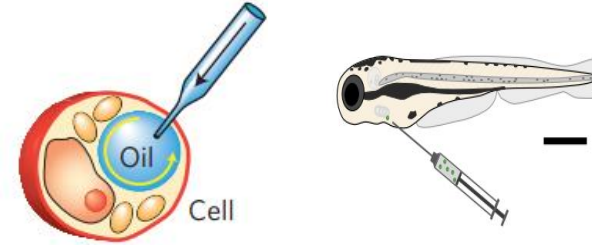
Flexible Microlasers



Mirrorless lasers



Biolasers

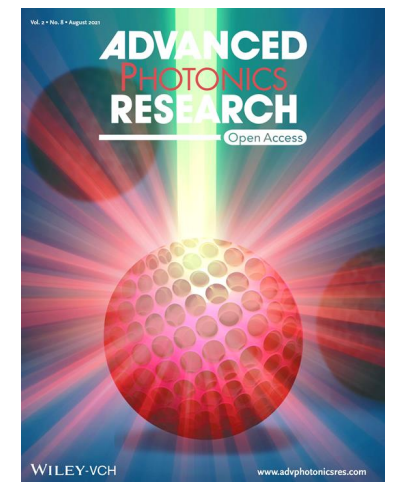
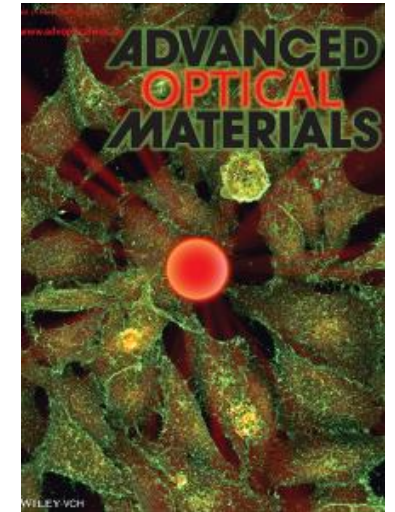


Convolutional Neural Networks

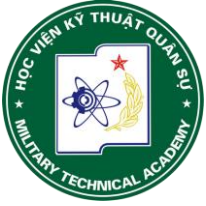
Cell Properties or phenotyping



Northeastern University



# Acknowledgement



Optoelectronics Lab



Professor SUN Handong



Nguyễn Văn Toàn



PGS. TS Mai Hồng Hạnh



COMPLEX NANOPHOTONICS RESEARCH GROUP



Nguyễn Trọng Tâm



TS Phạm Văn Nhất



Professor Riccardo Sapienza



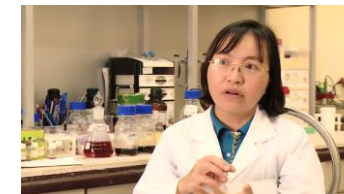
Dr Soraya Caixeiro



Dr Dhruv Saxena



Nguyễn Đức Trung



PGS. TS  
Nghiêm Thị  
Hà Liên

**Thank you for your attention!**