

EVENTO DE NETWORKING

## HEALTHCARE & PHOTONICS

TECNOLOGIAS FOTÓNICAS APLICADAS AL SECTOR HEALTHCARE

**26 MARZO/14**

09.45h-17.00h  
**Parc Audiovisual  
de Catalunya**  
Carretera BV-1274,  
Km.1, 08225 Terrassa  
(Barcelona)



## Quantum Dots (QDs) for cystic fibrosis (CF) diagnosis

Georgiana Stoica

## Prof. Emilio Palomares Group - Laboratory for nanoelectronics

### Photovoltaics

- Organic dyes
- Small molecules
- Quantum dots
- HyLEDs, OLEDs

SCIENTIFIC  
REPORTS



A Robust Organic Dye for Dye Sensitized Solar Cells Based on Iodine/Iodide Electrolytes Combining High Efficiency and Outstanding Stability

Damien Joly<sup>1</sup>, Laia Pellejà<sup>2</sup>, Stéphanie Narbey<sup>3</sup>, Frédéric Oswald<sup>3</sup>, Julien Chiron<sup>4</sup>, John N. Clifford<sup>2</sup>, Emilio Palomares<sup>2,5</sup> & Renaud Demadrille<sup>1</sup>

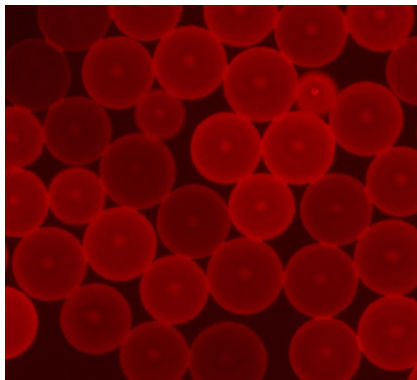
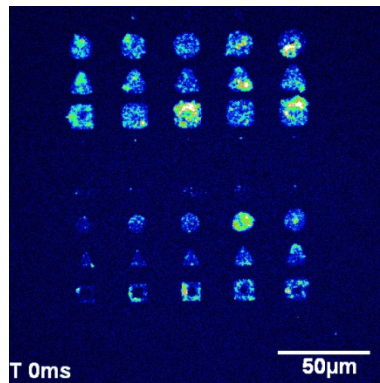
Windows of the EPFL's Convention Center

The EPFL's Convention Center (Lausanne, Switzerland) has 300 m<sup>2</sup> of dye-sensitized solar cells integrated to its façade and it represents the first application of such technology to a public building. The EPFL's Convention center will open on April 2014.

## Prof. Emilio Palomares Group - Laboratory for nanoelectronics

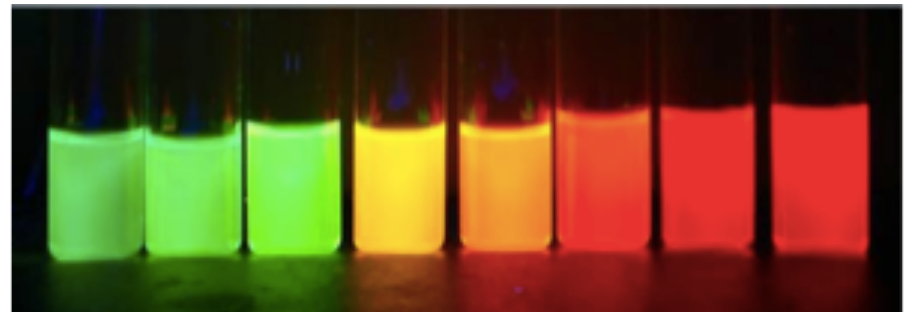
### Bio-medicine

- Quantum dots
- Up-conversion nanoparticles
- Embedded beads



### Collaborations

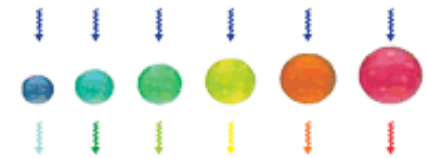
- Cystic Fibrosis (Nuria Mir, Plataforma Besitos Salados)
- Schizophrenia (Dr. Elisabet Vilella, IISPV, Spain)
- Down syndrome (Dr. Mara Diersen, CRG, Spain)
- Immunology & heart-related diseases (Dr. Mihaela Delcea, ZIK HIKE, Germany)
- Multiplex screening by Flow cytometry (Ikerlan, Bilbao, Spain)



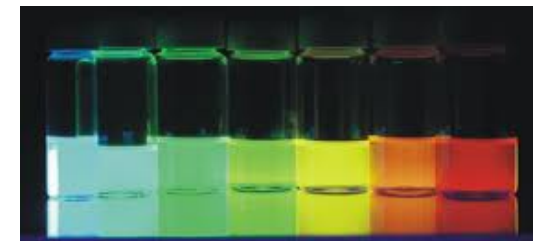
## Quantum dots (QDs)

- Optically and electrically active semiconductor inorganic nanocrystals
- Narrow and tunable emission spectrum (size-dependent)
- A single light source can excite QDs of many colors
- Higher brightness (20 x)
- Higher photostability (100 x more)

Simultaneous excitation at 365 nm

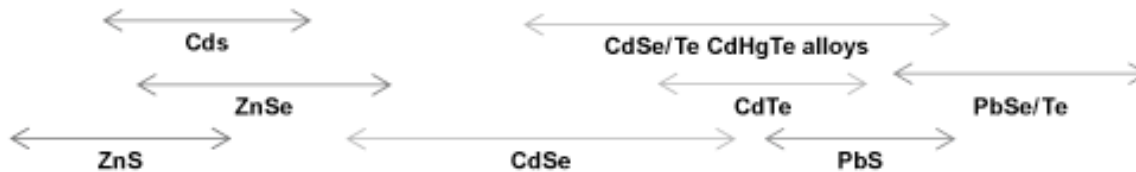
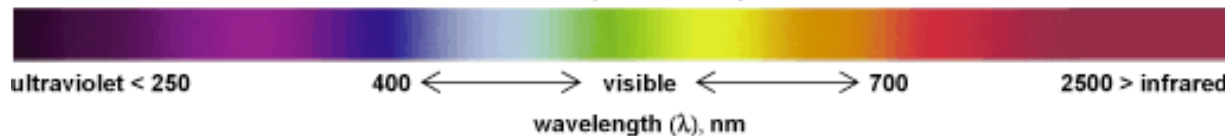
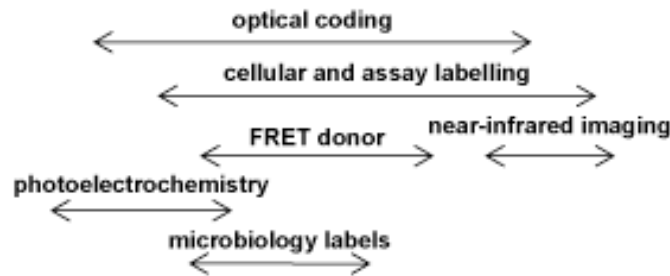
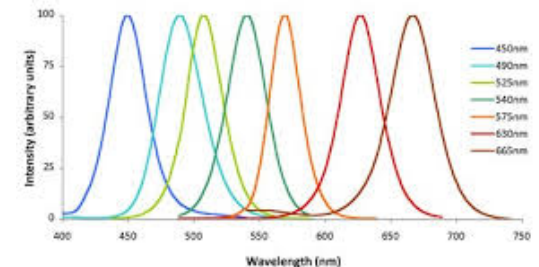


Size-dependent emission



2.3 → 5.5  
Size (nanometers)

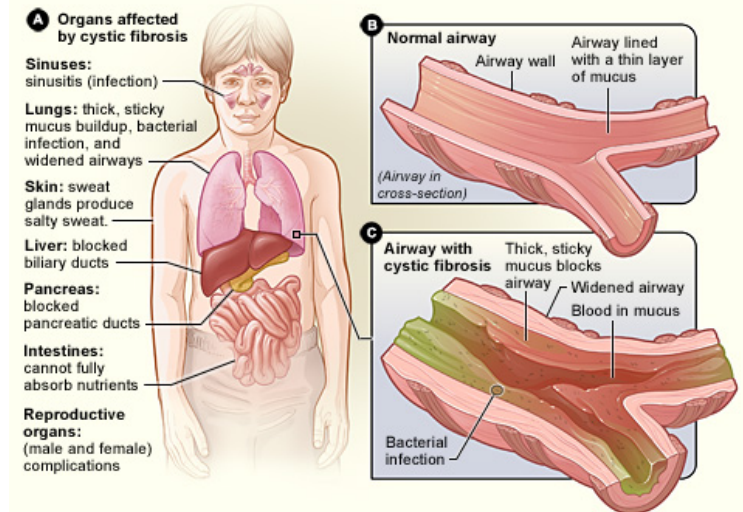
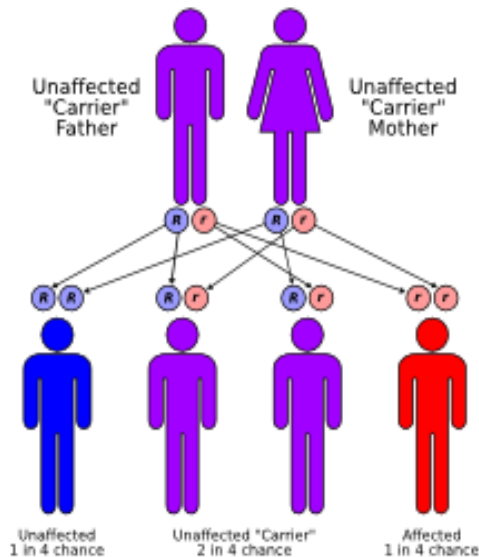
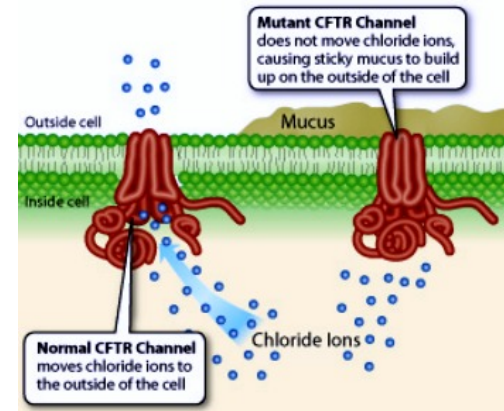
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## Quantum dots (QDs) for cystic fibrosis (CF) diagnosis

Cystic fibrosis (CF) is the most life threatening recessive genetic condition affecting Caucasian children

	Risk of CF Mutation	Risk of child with CF
Caucasian	1 in 25	1 in 2,500
Ashkenazi Jewish	1 in 29	1 in 3,364
Hispanic	1 in 46	1 in 9,600
African-American	1 in 65	1 in 15,300
Asian e.g. Indonesian, Indian etc.	1 in 90	1 in 32,000



## Cystic Fibrosis(CF)

- No cure so far
- Early detection of homozygous
- Improved life quality


250 Capsules • NDC 0032-1206-07

### CREON<sup>®</sup>

(pancrelipase)  
Delayed-Release Capsules


DOSE BY LIPASE UNITS	<b>Lipase</b>	<b>6,000</b> USP Units
	<b>Protease</b>	<b>19,000</b> USP Units
	<b>Amylase</b>	<b>30,000</b> USP Units

Each capsule contains pancrelipase in enteric-coated spheres.  
Dispense enclosed Medication Guide to each patient.

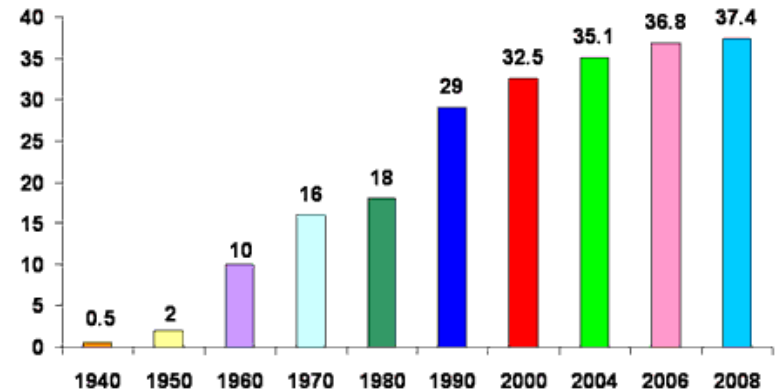


### FDA-Approved CREON<sup>®</sup>

CREON <sup>®</sup> 6,000 Lipase Units	19,000 Protease Units	30,000 Amylase Units
CREON <sup>®</sup> 12,000 Lipase Units	38,000 Protease Units	60,000 Amylase Units
CREON <sup>®</sup> 24,000 Lipase Units	76,000 Protease Units	120,000 Amylase Units



### Average Life Expectancy in Cystic Fibrosis Better Treatment = Improved Survival



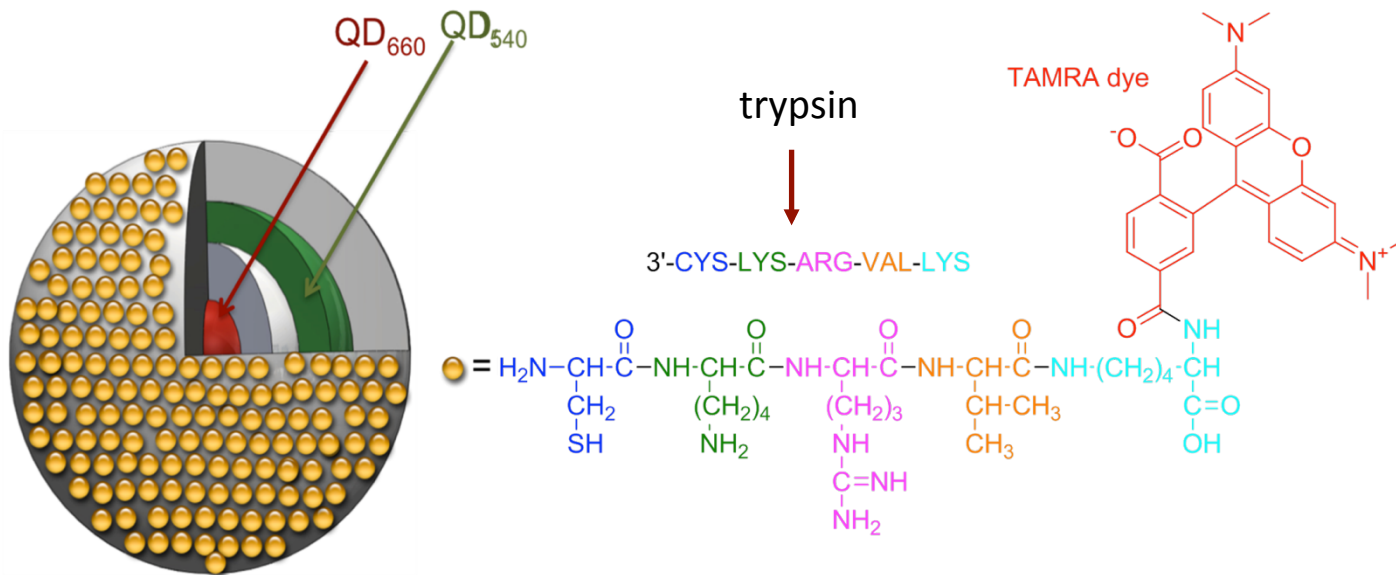
Source: Cystic Fibrosis Foundation

## Cystic Fibrosis: available diagnosis methods

Method	Description	Pros	Cons
Sweat test	Measurement of chloride concentration in sweat	<ul style="list-style-type: none"> <li>- cheap</li> <li>- easy to implement</li> <li>- fast</li> </ul>	<ul style="list-style-type: none"> <li>- High number of false positives</li> <li>- unpleasant for newborns</li> </ul>
Immunoassays (Neonatal IRT assay DELFIA®, PerkinElmer)	Quantification of trypsinogen in blood by fluorescence assays	<ul style="list-style-type: none"> <li>- Reliable</li> <li>- Easy to implement</li> </ul>	<ul style="list-style-type: none"> <li>- High number of false positives</li> <li>- Invasive</li> <li>- Time consuming</li> </ul>
Genetic analysis	Genetic sequencing	Determination of patient phenotype, accurate	<ul style="list-style-type: none"> <li>- Time consuming</li> <li>- invasive</li> <li>- Expensive</li> </ul>

## ICIQ Cystic Fibrosis diagnosis kit: principle

Ratiometric sensor based on FRET (Förster Resonance Energy Transfer)  
3 color light-emitting QDs-embedded beads sensitive to trypsin activity

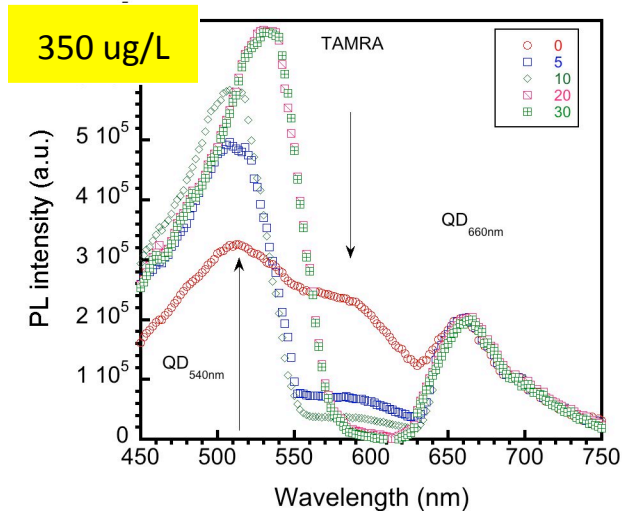
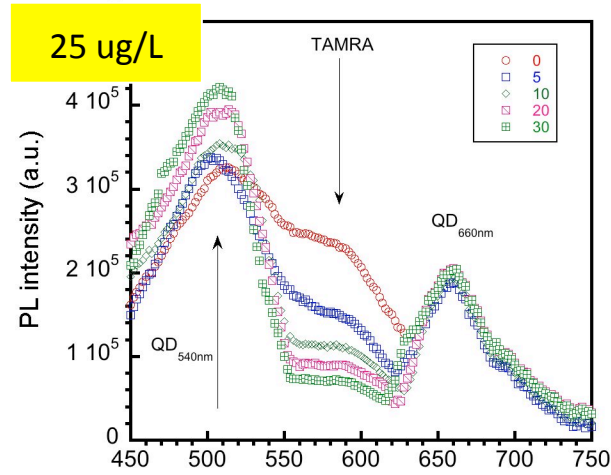
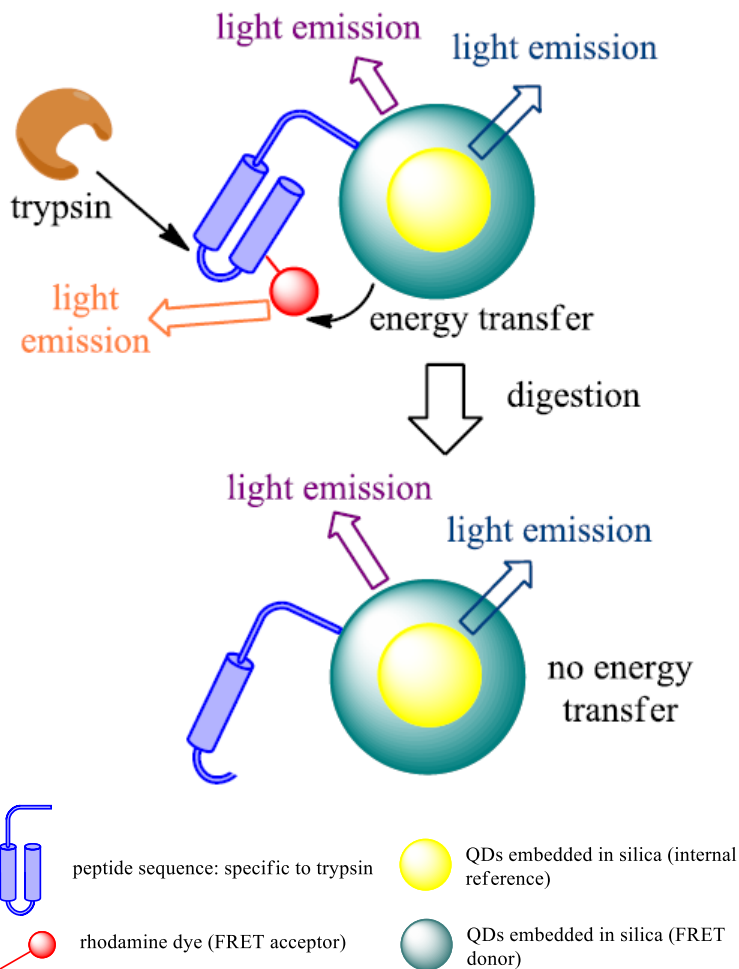


FRET: donor QD<sub>540</sub> – acceptor TAMRA dye



# ICIQ Cystic Fibrosis diagnosis kit: principle

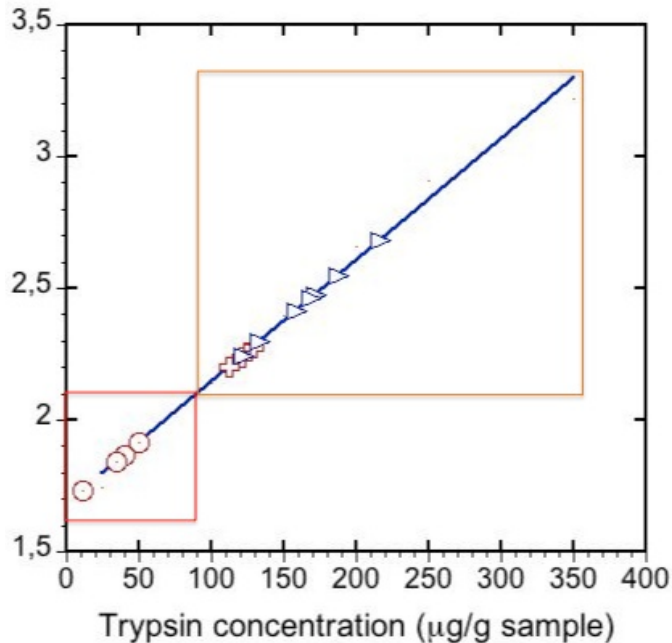
3 color light-emitting QDs-embedded beads sensitive to trypsin activity



Healthy 160-340 ug/L  
 CF heterozygotic 89-349 ug/L  
 CF homozygotic 0-90 ug/L

## ICIQ Cystic Fibrosis diagnosis kit: results

- Analysis of 11 samples (human feces)



Subject	Trypsin ( $\mu\text{g/g}$ )			
	as-measured		treated values	
A	171,98	$\pm 3,081$	171,98	$\pm 3,081$
B	121,92	$\pm 1,504$	121,92	$\pm 1,504$
C	129,19	$\pm 4,053$	40,05	$\pm 1,256$
D	217,01	$\pm 8,341$	217,01	$\pm 8,341$
E	188,04	$\pm 7,277$	188,04	$\pm 7,277$
F	121,15	$\pm 4,694$	10,9	$\pm 0,422$
G	168,58	$\pm 9,997$	168,58	$\pm 9,997$
H	158,85	$\pm 7,767$	158,85	$\pm 7,767$
I	111,89	$\pm 8,272$	34,69	$\pm 2,564$
J	133,41	$\pm 3,043$	133,41	$\pm 3,043$
K	128,93	$\pm 4,905$	50,28	$\pm 1,913$

Treated values correspond to medication taken by patient (ingestion of proteolytic enzymes): 8-10 capsules of Creon© 25,000 or 20 capsules of Creon© 10,000 daily, respectively.

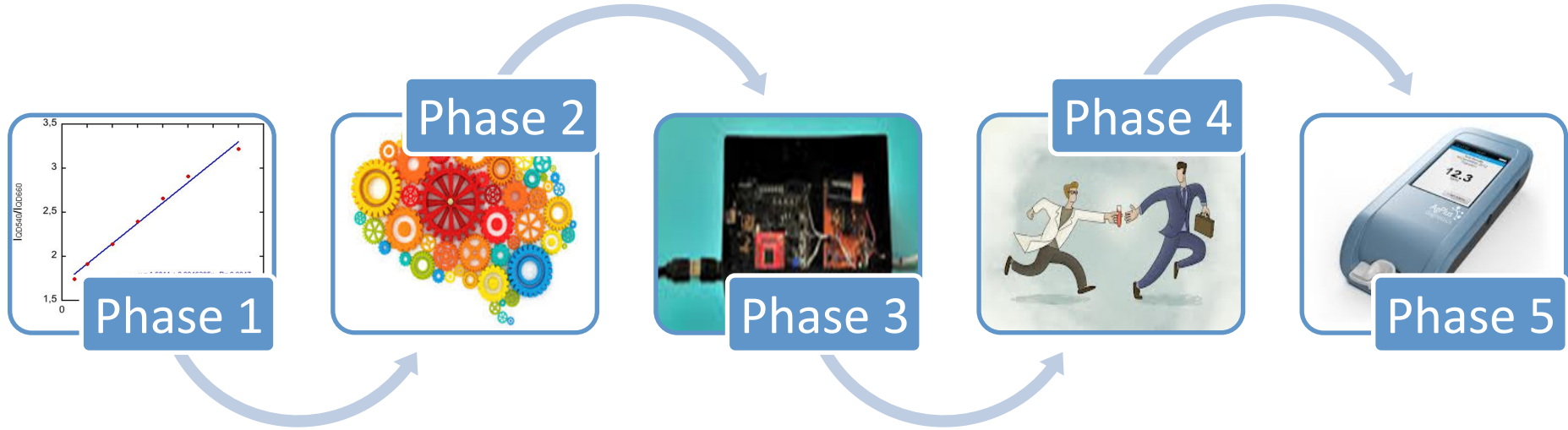
CF ratiometric sensor  
 4 CF homozygous and 7 CF heterozygous subjects  
 Patient genotype determination

## ICIQ Cystic Fibrosis diagnosis kit: summary

- Accuracy and precision of **quantitative analysis**
- **Genotype determination**
- Time of response (10 min)
- Portable method (applicable at point-of-care)
- **Non-invasive method**
- **Concept can be used to quantify other relevant biomolecules**
- Ease of implementation
- Cost-effective

EP patent application filed on 25/06/2013

# ICIQ Cystic Fibrosis diagnosis kit: development plan



**Laboratory scale:**

- Small scale
- Controlled conditions of analysis
- Reduced number of samples

**Method validation:**

- Multivariable analysis
- Several QD batches
- Systematic analysis procedure
- Calibration
- Stability tests
- Large number of samples

**Prototyping:**

- Development of a prototype
- Software development
- Life cycle analysis
- Comparison with previous results
- Statistical validation

**Technology transfer:**

- Marketing plan
- License
- Spin-off
- Funding
- Regulatory issues

**Product exploitation**

- Regulatory
- Manufacturing
- Sales

## Quantum dots (QDs) for cystic fibrosis (CF) diagnosis

### Team

#### Nanoelectronics Group

Prof. Emilio Palomares

Dr. Georgiana Stoica

Alba Matas Adams (PhD student)

#### CSOL Catalytic Solutions

Dr. Fernando Bravo (Unit Manager)

Dr. Iván Castelló Serrano

#### Industrial Property

Dr. Frederic Ratel (Unit Manager)



## Alianzas estratégicas con los pacientes

> **Ciencia** / Asociaciones de afectados por enfermedades minoritarias recaudan fondos y suman esfuerzos con centros de investigación para conseguir avanzar en su tratamiento o detección

Los familiares de los pacientes de enfermedades minoritarias han empezado a movilizarse para impulsar investigaciones que logren mejorar la calidad o la esperanza de vida de sus hijos y hermanos. Conscientes de que desde Cataluña se hace investigación puntera pero que a menudo faltan fondos -y más en medio de la crisis y los recortes actuales-, son los miembros de las asociaciones

quienes insisten y empujan a los investigadores a no desfallecer en el intento de curar o ayudar a sus familiares. En Cataluña existen casos de cómo los familiares de enfermos por fibrosis quística y ataxia de Friedreich se han unido al Institut Català d'Investigació

Química de Tarragona (ICTQ) y al Institut de Recerca Biomèdica de Barcelona (IRB) para tirar adelante investigaciones que podrían tener alcance mundial. La lucha por la enfermedad ya no es sólo diaria y doméstica. Los familiares de enfermos por estas do-

lencias que no tienen cura se convierten ahora en los mecenas de enfermedades que ni siquiera conocían antes de sufrirlas en primera persona. Ciencia y sociedad estrechan cada vez más lazos con recaudaciones de fondos o incluso con la cesión de muestras de los propios pacientes para permitir que los investigadores puedan llevar a cabo su ya no tan solitaria misión.

