

Imperial College  
London

# Bioengineering: Photonic Technologies in Medicine

Presented by Dr. Ali Yetisen  
Imperial College London



“Live” Masterclass

*Engage with Imperial academics live online!*

Modern medicine offers a wide range of biophotonic technologies for the non-invasive diagnosis and treatment of high-risk patients. The development of innovative biophotonic materials and components can reveal the human condition and enable early detection of diseases both at clinical and point-of-care settings. Biophotonic devices can be deployed to centralized facilities, hospitals, rural clinics and home environments to increase the efficiency in identifying and treating patients who need urgent or continuous care.

This master class will demonstrate the state-of-the-art technologies in biophotonic materials and components. This fundamental knowledge can be applied to the design, development and production of photonic technologies to create innovative industrial biomedical devices.

Participants will have a unique opportunity to work on a design project to develop photonic technologies for photomedicine applications.

## Topics covered include:

- Photonic Technologies in Medicine
- Lasers
- Optical Fibers
- Spectroscopy
- Microscopy and Imaging
- Photomedicine
- Design Projects

## Who should attend:

This masterclass is designed for UG or PG students studying in engineering, biology, chemistry, physics, biotechnology, computing or related disciplines with an interest in learning and applying photonic technologies to create innovative biomedical devices.

Pre-requisite: Students are expected to have a basic knowledge in chemistry and biology. For those who do not have basic knowledge of chemistry and biology, a pre-reading list will be provided before the class starts.

Upon completion of this masterclass, participants will receive a digital certificate from Imperial College London.

Centre for Continuing Professional Development  
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[www.imperial.ac.uk/cpd](http://www.imperial.ac.uk/cpd)  
Email: [cpd@imperial.ac.uk](mailto:cpd@imperial.ac.uk)

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CPD - Online “live” masterclass module

Module title:	<b>Bioengineering: Photonic Technologies in Medicine</b>
Academic Lead / Presenter	<p>Dr. Ali Yetisen (Ph.D., University of Cambridge; Postdoc, Harvard University) Associate Professor / Senior Lecturer Department of Chemical Engineering, Imperial College London <a href="https://www.imperial.ac.uk/people/a.yetisen">https://www.imperial.ac.uk/people/a.yetisen</a> <a href="https://www.imperial.ac.uk/yetisen-group">https://www.imperial.ac.uk/yetisen-group</a></p> <p>Invited speaker: Dr. Yunuen Montelongo (University of Oxford)</p>
Course Description and Outline	<p>Modern medicine offers a wide range of biophotonic technologies for the non-invasive diagnosis and treatment of high-risk patients. The development of innovative biophotonic materials and components can reveal the human condition and enable early detection of diseases both at clinical and point-of-care settings. Biophotonic devices can be deployed to centralized facilities, hospitals, rural clinics and home environments to increase the efficiency in identifying and treating patients who need urgent or continuous care.</p> <p>This masterclass will demonstrate the state-of-the art technologies in biophotonic materials and components. This fundamental knowledge can be applied to the design, development and production of photonic technologies to create innovative industrial biomedical devices.</p> <p>Participants will have a unique opportunity to work on a design project to develop photonic technologies for photomedicine applications.</p> <p>Topics covered include:</p> <ul style="list-style-type: none"> <li>• <b>Photonic Technologies in Medicine</b> To overview the concepts and applications of photonic materials and devices in medicine, focusing on diagnostics and optical treatment</li> <li>• <b>Lasers</b> To overview the fundamental technologies and applications in laser optics (solid state, liquid state, gas, semiconductor).</li> <li>• <b>Optical Fibers</b> To illustrate the current state-of-the-art fiber optic devices, providing the challenges and limitations in endoscopy applications.</li> <li>• <b>Spectroscopy</b> To demonstrate the applications of absorption, reflection and fluorescence spectroscopy and their utilization in medicine</li> <li>• <b>Microscopy and Imaging</b> To explore the approaches to collect optical information from a body fluid (blood, urine, cerebrospinal fluid) sample or biopsy tissue</li> <li>• <b>Photomedicine</b></li> </ul>

	<p>To explore low-level laser therapy (LLLT), photodynamic therapy (PDT) and photothermal therapy (PTT) and provide an overview of the state-of-the-art technologies in disease diagnosis and treatment.</p> <ul style="list-style-type: none"> <li>• <b>Design Projects</b> To develop a commercial biophotonic technology that will solve a global unmet problem in biotechnology or medicine</li> </ul>
Learning outcomes	<p>On completion of this masterclass, participants will be able to:</p> <ul style="list-style-type: none"> <li>• Overview the application of biophotonic technologies in diagnostics and treatment of patients</li> <li>• Describe the recent advances in laser optics and their utilisation in disease detection and treatment</li> <li>• Outline the basic knowledge about fiber optic technologies and waveguides in biophotonics and endoscopy</li> <li>• Explore the fundamentals and applications of spectroscopy technologies in biotechnology and medicine</li> <li>• Apply the knowledge and experience gained to conceptualize novel technologies in microscopy and imaging</li> <li>• Design and develop photonic technologies for photomedicine applications in light therapy and diagnostic device development</li> </ul>
Online teaching methods	<ul style="list-style-type: none"> <li>- Lectures will be delivered via Microsoft Teams.</li> <li>- Web based exercises and quizzes will be provided for formative feedback.</li> <li>- Group projects will be designed for assessing the learning outcomes, supported by tutorials.</li> <li>- Forum will be created via Teams for group discussions and questions.</li> </ul>
Who should attend?	<p>This masterclass is designed for UG or PG students studying in engineering, biology, chemistry, physics, biotechnology, computing or related disciplines with an interest in learning and applying photonic technologies to create innovative biomedical devices.</p> <p>Pre-requisite: Students are expected to have a basic knowledge in chemistry and biology. For those who do not have basic knowledge of chemistry and biology, a pre-reading list will be provided before the class starts.</p>
Certification	<p>Participants will receive a digital certificate from Imperial College London and a letter confirming their project score upon completion.</p>

Provisional schedule:

<p><b>Week 1</b>  <b>Session 1: Photonic Technologies in Medicine</b>  <i>Led by: Dr. Ali Yetisen</i></p>
<p>Content</p> <ul style="list-style-type: none"> <li>• Light in medicine</li> <li>• Current market trends</li> <li>• Photonic material innovation</li> <li>• Biophotonic device development</li> <li>• Future of photonic devices in medicine</li> <li>• Q&amp;A</li> </ul>
<p>Additional Project Briefing and Tutorials</p>
<p><b>Week 2</b>  <b>Session 2: Lasers</b>  <i>Led by: Dr. Ali Yetisen, Dr. Yunuen Montelongo</i></p>
<p>Content</p> <ul style="list-style-type: none"> <li>• Gas lasers</li> <li>• Solid-state lasers</li> <li>• Fiber lasers</li> <li>• Photonic crystal lasers</li> <li>• Semiconductor lasers</li> <li>• Dye lasers</li> <li>• Q&amp;A</li> </ul>
<p>Tutorial Session: Q &amp; A and feedback</p>
<p>Additional Project Briefing and Tutorials</p>
<p><b>Week 3</b>  <b>Session 3: Optical Fibers</b>  <i>Led by: Dr. Ali Yetisen, Dr. Yunuen Montelongo</i></p>
<p>Content</p> <ul style="list-style-type: none"> <li>• Principles of waveguides</li> <li>• Multi-mode fibers</li> <li>• Single-mode fibers</li> <li>• Optical fiber manufacturing</li> <li>• Applications in endoscopy</li> <li>• Q&amp;A</li> </ul>
<p>Tutorial Session: Q &amp; A and feedback</p>
<p>Additional Project Briefing and Tutorials</p>
<p><b>Week 4</b>  <b>Session 4: Spectroscopy</b>  <i>Led by: Dr. Ali Yetisen</i></p>
<p>Content</p> <ul style="list-style-type: none"> <li>• Absorbance, reflection and fluorescence spectroscopy</li> <li>• Spectrophotometer design</li> <li>• Smartphone spectrophotometers</li> <li>• Q&amp;A</li> </ul>
<p>Additional Project Briefing and Tutorials</p>
<p><b>Week 5</b>  <b>Session 5: Microscopy and Imaging</b>  <i>Led by: Dr. Ali Yetisen, Dr. Yunuen Montelongo</i></p>

<b>Content</b> <ul style="list-style-type: none"><li>• Phase contrast microscopy</li><li>• Fluorescence microscopy</li><li>• Confocal microscopy</li><li>• Two-photon microscopy</li><li>• Holographic microscopy</li><li>• Q&amp;A</li></ul>
Tutorial Session: Q & A and feedback
Additional Project Briefing and Tutorials
<b>Week 6</b> <b>Session 6: Photomedicine</b> <i>Led by: Dr. Ali Yetisen</i>
<b>Content</b> <ul style="list-style-type: none"><li>• Low level laser therapy (LLLT)</li><li>• Photodynamic therapy (PDT)</li><li>• Photothermal therapy (PTT)</li><li>• Applications in dermatology</li><li>• Q&amp;A</li></ul>
Additional Project Briefing and Tutorials
<b>Week 7</b> <b>Session 7: Project Presentations</b> <i>Led by: Dr. Ali Yetisen</i>
<b>Content</b> <ul style="list-style-type: none"><li>• Group project presentations</li><li>• Q&amp;A and feedback</li><li>• Announcement of winning project group</li></ul>