BIOTECHNOLOGY
Bionanotechnology
From Theory to Practice
Contents

Why Cambridge Advance Online? 03
Welcome to Bionanotechnology 04
Course Summary 05
What you will learn on the course? 06
The learning journey 08
Learning breakdown 10
Course modules 11
Meet your tutor 13
Technical requirements 14
Course certification 14
Why Cambridge Advance Online?

We are delighted to offer this exciting programme of short online courses for professionals, giving you the opportunity to harness the latest research, innovation and thinking that the University of Cambridge has to offer.

Cambridge Advance Online brings together the academic strength of the University, and the publishing and assessment strengths of Cambridge University Press and Cambridge Assessment, allowing you to develop your skills and specialise in emerging areas that address global challenges.

Our certificated courses will reflect the Cambridge experience and values, with low student to tutor ratios and academically rigorous standards. They will allow you to engage directly with academics at Cambridge and are centred on rich interaction between students and subject experts. Each course will offer you the opportunity to join live sessions with academics and interact in collaborative exercises with learners worldwide.

The University of Cambridge is committed to supporting lifelong learning and, through Cambridge Advance Online, has invested in the latest education technology to provide professionals with the very best experience wherever they are in the world and at any stage of their career.

We look forward to welcoming you onto one of our courses and to our global community of learners.

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Professor Graham Virgo
Senior Pro-Vice-Chancellor (Education)
2020 was a good year for bionanotechnology, a field that helped us design mRNA vaccines and get us through the pandemic.

It is difficult to pinpoint the exact moment the field emerged; like with many other interdisciplinary fields, disciplines merged together providing several important points in time for the field’s evolution. An important moment was the preparation of stable gold nanoparticle DNA hybrids that can be used as colorimetric sensors and design of first liposomal drug carriers in 1990’s. These developments went hand in hand with the sequencing of the human genome, advances in protein expression and labelling, introduction of superresolution fluorescent microscopy and a deeper understanding of the world on a nanoscale.

As we progressed over the last 30 years, we have learned that bio-nano hybrids are all around us. Venus flower basket sponge builds intricate silica scaffolds by combining layers of silica nanoparticles with proteins, while water-repelling properties of lotus plants stem from nanosized pillars of biopolymers within the leaf. Who would have thought that the beautiful insect colours are the result of the interaction between sunlight with the intricate nanostructures within their wings and shells?

We are only just starting to grasp some of the nanostructural elements in Nature, and as we learn more about them, they will help us design better materials and provide new solutions for the challenges ahead. After all, we have a planet to take care of and environmental challenges to address.

Bionanotechnology will not solve all the problems alone, but it can help us understand how can we combine man-made structures with biomolecules and use nature-inspired design to obtain drug-delivery systems, imaging agents for healthcare, new generation of solar cells and batteries for energy, and biocompatible materials and technologies to deal with pollution, and increased demands for food product. However, maybe the most important lesson we can learn from the bionanotechnology is that the best solutions are those that cross disciplines and do not shy away from demanding questions and seemingly unrelated answers. Within this course we will ask those questions, discuss the answers, and have lots of fun in the process.

Dr Ljiljana Fruk
Course Summary

Timetable:
September | January | April | June

Subject area:
Biotechnology

Format and length:
8 weeks | 8 hours per week

Price:
£1,950

This course provides an up-to-date overview of the rapidly developing area of bionanotechnology. Learn from a leading academic in the field who is based at the internationally recognised Department of Chemical Engineering and Biotechnology at the University of Cambridge.

The course is grounded in biomedical applications but the techniques you will learn are applicable to a range of industries including energy, agriculture and the environment. The interdisciplinary approach will allow you to develop a network of potential future collaborators.

Guided by our experts, you will explore the field through experiments and learn how to interpret and draw conclusions from your data. By the end of the course, you will be able to communicate your findings to a range of stakeholders to help secure project support and funding, and tackle challenging issues with bionano-inspired solutions.
What you will learn on the course?

By the end of the course, you will be able to:

– design a functional material or device using bionano elements

– describe how bionanotechnology can be used to address current challenges in the fields of medicine and biosensing

– choose and apply an appropriate Bionanotechnology strategy to existing solutions or structures

– decide on analytical methods and appropriate combinations to be used to characterise a particular bionano system

– make informed decisions on alternative analytical strategy based on cost/availability analysis

– communicate the unique value proposition of your strategy and communicate this convincingly to a range of stakeholders

Is this course right for you?

This course will be of interest to, but not limited to, the following:

– graduate students with a science or engineering background

– stakeholders working in research and development

– lecturers

– medical students and clinical researchers

– biotechnology consultants

– intellectual property experts

– policy makers
Key learning objectives

- Make connections between a natural and man-made bionano structure (nb sustainability, accessibility, inspiration from nature)
- Explain the differences between nano and bulk materials.
- Propose the most suitable strategy of biofunctionalisation of man-made nanostructures according to the application
- Differentiate between covalent and non-covalent strategies for biofunctionalisation of nanomaterials
- Identify the advantages and drawbacks of different strategies for nanomaterial preparation
- Propose functional materials and devices based on DNA nanostructuring
- Distinguish between different types of biosensing devices
- Construct a basic drug nanocarrier to address a given biomedical challenge
- Assess the role of bionano hybrids in tissue engineering
- Discuss the role of nanotoxicology and the challenges associated with development of bio-nano hybrids.
- Identify the key issues with scaled up manufacturing of the bionanotechnology elements
- Develop interdisciplinary thinking
The learning journey

Cambridge Advance Online courses are delivered over 6 to 8 consecutive weeks (dependent on the programme), with each week’s content following a clear, deliverable path to help facilitate learning.

Orientation
You will get access to familiarise yourself with our learning platform, Canvas, start networking with peers and hear from your course leader.

Week 1  Week 2  Week 3
*The duration of the programme is dependent on the course. Please check the course summary for information regarding course length in your organisational context.
Learning breakdown

Our online courses combine several different elements to create a balanced blend of learning. Participants will be able to learn at their own pace during the week, viewing content, engaging in discussions and completing any assignments. On average, our courses take 8 to 10 hours per week.

- **Built content**: (e.g. videos, animations, quizzes, case studies, worked experiments)
- **Research**: (e.g. reading, looking for info online etc.)
- **Discussion**: (via case study tasks)
- **Live session**

![Time allocation for different learning activities](image-url)
Course modules

Module 1
Nano
You will learn to differentiate between nano and bulk materials, and explore unexpected uses of specific bionanotechnology developments. You will also study the basics of the other disciplines that make up the science of bionanotechnology in order to be able to communicate effectively with potential collaborators in future.

Module 2
Problems
In this module you will explore some of the challenges in healthcare and tissue engineering, biosensing, material design for energy, sustainability and the environment. You will also identify a problem that can be solved using bionanotechnology that you will work on in your assessment.

Module 3
Existing solutions
In this module you will examine existing bulk or nano solutions to the problems you explored in Module 2 and evaluate their suitability, sustainability and scalability. You will look at nanocarriers and biosensing devices and biofunctionalisation of nanomaterials.

Module 4
Strategy
In this module, you will come up with new biofunctionalisation strategies, biosensing devices or nanocarriers to address given problems and use this analysis to propose a bionanotechnology solution to the problem you outlined in Module 2.
Course modules

(Continued)

Module 5

Viability

In this module you will reflect on the advantages and drawbacks of different strategies for nanomaterial preparation and propose solutions or alternatives to key issues with scaled up manufacturing of bionanotechnology elements.

Module 6

Assessment

In this module you will spend time collating your work on the problem you identified and the solution you propose as well as practical concerns of making this solution a reality. You will include these in a ‘proposal’ that synthesises key bionanotechnology concepts to communicate them to a lay audience. You will submit this for tutor feedback but this will ultimately be of use to you in seeking funding or research partners after the course finishes.
Ljiljana completed her studies in chemistry at the University of Zagreb and obtained PhD in biospectroscopy of DNA from University of Strathclyde, Glasgow.

She was then awarded Humboldt Fellowship followed by Marie Curie Fellowship to conduct postdoctoral research in enzyme reconstitution and nanomaterial biofunctionalisation in Prof. C. Niemeyer’s group at the University of Dortmund. After being group leader at the Karlsruhe Institute of Technology for 7 years, she took on the lectureship in bionanotechnology at the University of Cambridge in 2015. Her research interest is the use of bio and nanoelements to design materials for catalysis and healthcare applications. This involves development of new types of light-responsive structures, DNA nanostructuring and design of biopolymer-based drug nanocarriers.

She is a Fellow of the Royal Society of Chemistry and Cambridge Philosophica Society.
Technical requirements

- Sufficient internet speed and stability for video streaming (2 Mbps up/down)

- Please see our recommendations on web browsers: https://bit.ly/2S4Qhh4

Course certification

You’ll be assessed using a range of modalities that emphasize real-world application of course material. On completion of your Cambridge Advance Online course, you will be eligible for a Certificate of Achievement and digital badge.

To get your Certificate you must achieve a minimum grade of 70% on course activities and your final tutor-marked project.
If you have any questions or would like more information about our online courses, please contact our Enrolment Advisors at advanceonlinesales@cambridge.org