UCL SUMMER SCHOOL

NANOTECHNOLOGY IN MEDICINE

Key Information

<table>
<thead>
<tr>
<th>Module code</th>
<th>ISSU0051</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taught during</td>
<td>Session One: Monday 1 July - Friday 19 July 2019</td>
</tr>
<tr>
<td>Module workload</td>
<td>45 teaching hours plus approximately 100 study hours</td>
</tr>
<tr>
<td>Module leader</td>
<td>Kate Ricketts and Gavin Jell</td>
</tr>
<tr>
<td>Department</td>
<td>Nanotechnology, Faculty of Medical Sciences</td>
</tr>
<tr>
<td>Credit</td>
<td>15 UCL credits, 7.5 ECTS, 4 US</td>
</tr>
<tr>
<td>Level</td>
<td>Level 2, second year Undergraduate</td>
</tr>
<tr>
<td>Pre-requisites</td>
<td>A minimum of one year of undergraduate study (or research experience in a relevant field). Students are encouraged to apply from a broad range of degrees including but not limited to: biological science, biomedical science, physics, chemistry, biophotonics, material science, mathematics, engineering, medicine or a biotechnology related subject.</td>
</tr>
</tbody>
</table>

Assessment

Students (in groups) will profile the research of a UCL academic exploring nanotechnology in medicine and present a poster based on this research question/theme (25%), online Single Best Answer quizzes and interaction with storylines (25%), unseen short answer written examination, 2 hours (50%)

Module Overview

The use of nanotechnology in medicine is an emerging field that can revolutionise the treatment and detection of disease. Through hands-on laboratory sessions, workshops and lectures by world-leading researchers and active clinicians, this module offers both an insight into these emerging technologies and a fundamental understanding of why size matters and how nanoscale technologies interact with biological environments. We will visit the nanoscale quantum universe, and see how nanoscale objects can be tuned for disease targeting. Students will see how this small scale technology offers huge leaps in diagnostics and therapeutics, enabling us to break the boundary from macroscale anatomy to nanoscale biologics.

Week One:
- An introduction to nanomedicine – why size matters.
- Physics on the nanoscale
- Nanomaterials used in medicine (including carbon nanotubes, gold nanoparticles and Quantum dots)

Week Two:
- Targeted nanoparticle drug delivery (active and passive delivery)
- Nanoparticle drug release systems
- Nanoparticles in radiotherapy

Please note that this module description is indicative and may be subject to change.
- Nanoparticles for imaging (Quantum Dots)

Week Three:
- Nanoscale tissue engineering
- Nanotoxicity
- Practical nanoparticle workshops

Module Aims
This module introduces students to the use of emerging nanotechnologies in medicine. It aims to define what the bio-nanotechnologies are, to describe the physics of why material properties change at the nanoscale and how medicine and biological environments operate within the nano-realm. The module aims to explore the exciting possibilities of nanoscale tissue engineering and how nanoscale engineerability can address current limitations of imaging and therapy delivery in terms of intelligent targeted solutions. An overarching aim is to ensure that the module content is delivered in format that ensures students take a critical approach to this field, in order to distinguish the hype from the reality.

Teaching Methods
This module will be delivered through taught lectures delivered by academic and clinical experts, and learning enriched through interactive flipped lectures (storylines) that will be accessed by students through our e-learning environment (Moodle) and practical workshops.

Using the flipped lecture model, students will participate in small group tutorials of about 15 students to consolidate their knowledge and understanding. The tutorials will aim to develop the students’ critical approach to science and metacognitive skills. The coursework assignment will expose the students to the depth of research performed in nanomedicine at UCL and enable networking opportunities. Furthermore, the students will engage with clinicians (e.g. from radiation therapy and imaging) to gain real world experience of how nanotechnology can benefit the imaging and treatment of patients, and perform lab-based practicals to enhance their learning experience.

Learning Outcomes
Upon successful completion of this module, students will:
- Understand why size matters in medical applications of nanotechnology.
- Understand the impact of the nanoscale on the laws of physics, and resulting effects on chemical and biological interactions.
- Understand how nanotechnology can be applied to clinical imaging modalities to increase sensitivity and specificity of: (i) magnetic resonance imaging, (ii) x-ray based imaging.
- Understand how nanotechnology can be applied in radiotherapy to enhance tumour cell kill and localise cancer treatment.
- Understand how nanotechnology is applied in the delivery and targeted release of drugs.
- Be able to describe how nanoscale sized topographies and particles can influence biological interactions (including cell behaviour) with reference to tissue engineering and regenerative medicine.
- Understand what nanotoxicity is, how it is measured and why it is an important consideration in nanomedicine.
Assessment Methods

- Students (in groups) will profile the research of a UCL academic exploring nanotechnology in medicine and present a poster based on this research question/theme (25%)
- Online Single Best Answer quizzes and interaction with storylines (25%)
- Unseen short answer written examination, 2 hours (50%)

Key Texts

1. Nanotechnology: a gentle introduction to the next big idea - Ratner, Mark A., Ratner, Daniel c2003
2. Nanotechnology - Schmid, Günter c2008-
3. Quantum theory cannot hurt you: a guide to the universe - Chown, Marcus 2007
5. MRI from Picture to Proton - Donald W. McRobbie, Cambridge University Press 2006
6. Radiobiology for the Radiologist, E. Hall, A. Giaccia, Lippincott Williams & Wilkins, 2012
7. Intelligent surfaces in biotechnology: scientific and engineering concepts, enabling technologies, and translation to bio-oriented applications - Grandin, H. Michelle, Textor, Marcus c2012