UNIVERSITY OF OXFORD

This course is about biological molecules and how they assemble to make living cells and organisms. It illustrates how modern techniques, and the information acquired, are fundamental for studying most branches of life sciences

Biochemistry (C700)

MBiochem BIOCHEMISTRY

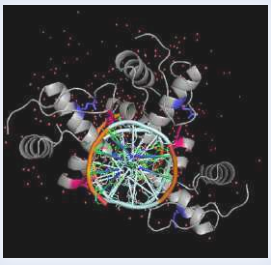


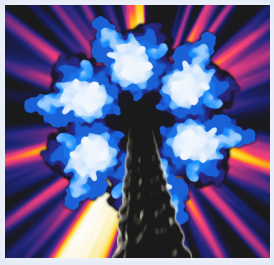


www.bioch.ox.ac.uk

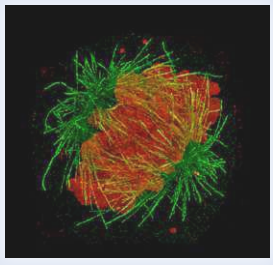
Department of Biochemistry

The Department was established over 100 years ago. Centred on a modern, award winning building, it houses over 45 independent research groups; these cover a wide range of disciplines which include genetics, computational biology, atomic resolution structure determination and glycobiology. The collective research aims are to arrive at a full understanding of the chemistry and assembly of molecules in living cells and how this relates to the physiology and development of multicellular organisms. These research goals are facilitated by close links with other Departments in Oxford, including Chemistry, Biology, Physiology, Pathology, Pharmacology, Physics and Molecular Medicine. According to the 2021 Research Excellence Framework assessment, over 90% of Oxford's Biological Sciences research, of which we are part, was rated as internationally excellent or world leading in terms of significance, rigour and originality. Three Nobel Prize winners (Hans Krebs, Rodney Porter and Paul Nurse) have been members of the Department.





FtsK is a DNA motor protein that acts in bacterial chromosome segregation. The left panel shows a crystal structure of it bound to DNA and the centre panel shows a schematic of FtsK, which can travel at speeds approaching 18,000 base pairs (~1000 molecule-lengths) per second. By comparison, the fastest manned aircraft can reach speeds of up 30 body-lengths per second. David Sherratt lab.



HeLa cell in mitosis. Imaged with super 3D-structured illumination microscopy. By Lothar Schermerlleh

What is Biochemistry?

Biochemistry, the study of life at the molecular level, continues to undergo rapid expansion and development. Powerful new techniques, for example in molecular genetics and structure determination, enable us to analyse biological phenomena in more and more precise molecular terms. Biochemistry gives us ever increasing insight into topics as various as the origin of life, the nature of disease and the development of organisms from a single cell to assemblies of specialised cells. As well as answering fundamental questions it has also led to commercially valuable developments in drug design, forensic science, environmental sensing and many other areas. The powerful tools developed for biochemical studies have been adopted by many other disciplines including medicine and evolutionary biology.

Why study Biochemistry at Oxford?

1st year undergraduate practical class. Photo: Anna Caughey

Our 4-year integrated Masters course, taught both in the Department and College, gives a comprehensive introduction to the subject. The course is well established and has been fine tuned over many years. It is certified to provide Bologna compliant level 7 qualifications. There is a coherence and sense of community in the Department, as well as high quality interdisciplinary research expertise, that helps us provide a flexible, efficient and cutting-edge course.

Training in Biochemistry is valuable because it plays an important role in many areas, including health, the environment and agriculture. The level of employment for Biochemistry graduates is high – our graduates find places in a wide range of industries, in medical research, in agriculture, in education, and in patent law to name but a few.

"The Biochemistry course was equal measures fascinating and rigorous. It was the best thing I could have done to prepare me for steps after university; I have transitioned into teaching Biology and use my degree every day. I am confident that wherever life takes me, the transferable skills I learnt at Oxford will stay with me"

Rosie became a sicence teacher after graduation

How is the course structured?

The course takes four years and has an intake of about 100 students per year.
It is divided into three sections:

		Examples of topics covered		
FIRST YEAR	CELLULAR BIOCHEMISTRY	Cell structure and organisation	Metabolism and its control	Cell sensing and signalling
	MOLECULAR BIOCHEMISTRY	From DNA to proteins: Information transfer	From genotype to phenotype	Protein structure and function
	MECHANISTIC BIOCHEMISTRY	Organic chemistry of biomolecules	Protein strcture and chemistry	Carbohydrates in biochemistry
	PHYSICAL BIOCHEMISTRY	Thermodynamics	Atomic & molecular structure	Regulation of enzymatic reactions
	QUANTITATIVE BIOCHEMISTRY	Differentiation & Integration	Graphical representations	Statistics and the scientific method
				PRELIMINARY EXAMINATIONS
SECOND & THIRD YEAR	TOOL BOXES FOR BIOCHEMISTRY	How do I isolate and characterise a gene?	How do I understand protein interactions?	How do I visualise events in a cell?	How do I predict protein structure?
	INFORMATION TRANSFER	How is DNA packaged in the cell?	How do cells copy and maintain chromosomes?	How is chromatin accessed?	How are genes expressed?
	MOLECULAR PROCESSES IN THE CELL	How does cell signalling work?	How are proteins processed?	How do chemicals move across membranes?	How do neurons convey information?
	CELLULAR CHEMISTRY	How do cells do chemistry?	How do cells make energy?	How does life survive without light and oxygen?	How do prokaryotes affect health and the environment?
	THE CELL IN TIME AND SPACE	What are the principles of development?	How is a nervous system put together?	What are the principles of the immune response?	What is cancer?
					PART I EXAMINATIONS
FOURTH YEAR	RESEARCH PROJECT	One of the most distinctive features of the course is the research project. Here, you spend 23 weeks full time in a research laboratory where you will be a member of a research team, gaining extensive first hand experience of the rewards (and frustrations) of research. A wide choice of research projects is available within Biochemistry or other University departments such as Molecular Medicine, Pathology, Pharmacology, Chemistry, Physics amomg others. Two additional weeks are allowed to write a short thesis on your project, that together with a related 10 minute presentation will make up 25% of your final degree.			
	COURSEWORK	Alongside the research project you will write a review article for specialists in an area of interest to you, with advice from an expert in this area. This also counts towards your final degree result.			
					PART II ASSESSMENT

"The Oxford biochemistry course gave me not only a thorough grounding in a range of specific biochemistry topics, but also a deep understanding about the practical processes of scientific research in general. My work in science communication and engagement has all stemmed from the experiences and opportunities I gained through this course"

James, a graduate of the course who now works in science communication

Teaching at Oxford University

Lectures

There are usually about 10 lectures a week held in and around the Department. The lecture material defines the course, and forms the basis of your examinations. The course is kept under constant review by a Steering Committee which contains representatives of the student body as well as members of the academic staff. In this way new developments in the subject, and requests from students for teaching in particular areas, can be incorporated into the course.

Practical Classes

These are run throughout the course in parallel with lectures. Some are lab based (wet) practicals, which introduce you to the basic techniques used in research laboratories; others involve computer-based work (e.g. on manipulation of databases and molecular structures) or the assessment and interpretation of experimental data. First year practicals tend to last for one day, but in later years longer practicals allow you to devise and complete more challenging experiments, and serve as an introduction to the more independent research you will carry out in your fourth year.

Tutorials

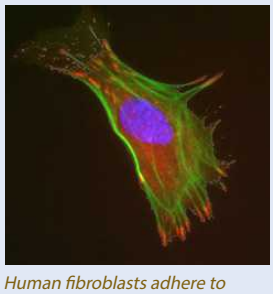
Tutorials allow you to study individual topics in more depth and also to clarify lecture topics in small group discussions. Your college tutor will arrange at least one tutorial a week for you (normally with a partner). This may be with your personal tutor, or with other tutors to learn about their specialist areas. For a tutorial, you are given a reading list in advance; this reading then forms the basis for discussion in which you will be expected to show that you understand the topic in question and the experimental evidence that underlies it.

The Research project

Carried out in the fourth year and under the supervision of the group leader, you will be able to design your own experiments, and will learn to plan a research programme and present your results and ideas to other workers in the field, and – in your dissertation – write them up in a form suitable for publication. The experience gained and the extra maturity acquired during the fourth year are much valued by employers, and you will also have the opportunity to reflect on your aptitude and enthusiasm for a research career.

A fruit fly's third instar larval brain stained by Phalloidin (green, cell boundary) and DAPI (red, nuclei).

An unusual nematode mutant where certain nuclei form clusters rather than being correctly spaced. Prof Alison Woollard's lab.



Human fibroblasts adhere to fibrillin-1
Professor Penny Handford's Lab

The magnet for a very high field - 22.3 Tesla - NMR instrument.

Roles of the Department and Colleges

Photo: Rob Judges

Oxford is a collegiate university, which means that all students are admitted by, and become members of, a college.

The biochemistry course is organised and largely taught by the Department. Lectures, classes, practicals, research projects and exams are all provided centrally. The undergraduate admissions process is also centrally coordinated by the Department. This means that your chance of getting an offer of a place and the education that you receive after you have arrived does not depend on the College to which you apply (and many students happily end up at a college different to the one they originally applied to).

Colleges provide a personal tutor who will supervise your studies and monitor your progress. Your tutor will give some tutorials and organise the others. They can provide lots of advice, and make sure that you get any additional help that you may need during your studies. Your college also provides accommodation (for some or all of your course), meals and a wide range of social and sporting activities.

The combination of teaching in the Department and more individual teaching and guidance in college is one of the major strengths of the Oxford system.

What qualifications will I need?

Photo: Anna Caughey

Typical offer for successful candidates:
A-levels: A*AA including Chemistry and another science or Maths, with the A* in Maths, Physics, Chemistry, or Biology (or a very closely related subject)
Advanced Highers: AA/AAB
IB: 39 including core points
Or any other equivalent.

Full details on the Departmental website

Maths to A-level or the equivalent is very helpful to students in completing the course and, although not required for admission, may make an application more competitive. Biology beyond GCSE or the equivalent (e.g. to AS-level, Scottish High, Standard level in the IB) can be helpful to students in completing the course, although it is not required for admission.

What can I do after I finish my degree?

Biochemistry is an expanding area and graduates have no difficulty in finding employment at the end of their course. You may embark on a research career by studying for a higher degree and about half our students do so. Alternatives can be to enter industry, the health service, or the scientific civil service. However, the course also provides a broad intellectual training. You emerge with some familiarity with mathematical methods and quantitative reasoning, and a proper understanding of rigorous scientific method. These skills are of great value in jobs that are not necessarily directly related to biochemistry. Our students find posts in accountancy, computing, management, advertising, the health and civil services, teaching and many other areas. The Careers Service offers helpful guidance.

Admissions

For more information on applying to Oxford, please visit www.admissions.ox.ac.uk.

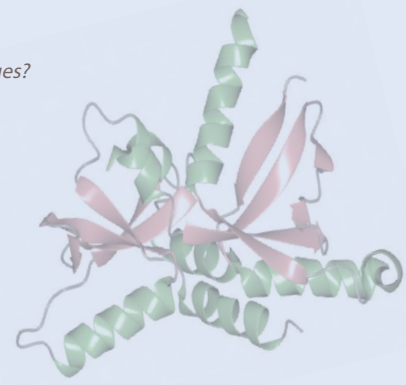
Open Days

There's no better way to find out what Oxford is really like than to visit us. Many colleges and departments welcome arranged visits throughout the year but our University open days remain the most popular time to visit. Explore colleges and departments and to talk directly to tutors and students to help you make your decisions. For details, please see: www.admissions.ox.ac.uk/opendays

From a first year undergrate poster by Jonathan Goult

Would you like to know how the story continues?

Go to: www.bioch.ox.ac.uk/lysoholmes



Structure of the Tic22 protein that is found in the malaria parasite, Plasmodium falciparum and in algae, from where the parasite evolved. Prof. Matt Higgins.

Photo: Jeremy Rowntree

Research in the Department

The following is a list of the senior research staff of the Department, and the Biochemistry tutors for those Colleges admitting biochemists. From it you will get some idea of the scope of biochemical research going on in Oxford that underpins the undergraduate course. It is by no means an exhaustive list. More details can be obtained from the Department website at www.bioch.ox.ac.uk/research

Professor Francis Barr (Head of Department): Molecular mechanisms of cell division
Professor Neil Brockdorff FRS: Developmental epigenetics
Dame Professor Amanda Fisher FRS: Cell identity and epigenetic inheritance
Professor Matt Higgins: Structural studies of the malaria parasite
Professor Colin Kleanthous: Protein-protein interactions in bacterial cell signalling and protein import
Professor Simon Newstead: Studies of membrane proteins
Professor Bela Novak: Dynamics of cell cycle controls
Professor Rob Klose: Epigenetic regulation of chromatin function
Professor Nicole Zitzmann: Development of host target based antiviral strategies

Professor Ben Berks FRS *(Wadham):* Protein Transport; Molecular Microbiology; Membrane Proteins; Molecular Machines
Assoc. Prof. Rachael Bashford-Rogers *(Lady Margaret Hall):* From adaptive immunity to clinical translation
Assoc. Prof. Lindsay Baker *(Merton)*: Building up complexity within situ structural biology
Professor Phil Biggin *(Lady Margaret Hall)*: Computational approaches to receptor dynamics and ligand binding
Dr Mary Board *(St Hilda's)*: Metabolic control relating to diabetes/obesity
Assoc. Prof. Lynne Cox *(Oriel)*: Cellular senescence and ageing
Assoc. Prof. André Furger *(Pembroke)*: Control of gene expression in eukaryotes
Professor Rob Gilbert *(Magdalen and Nuffield Department of Medicine)*: Cell signalling, adhesion and pore formation in human disease
Professor Penny Handford *(St Catherine's)*: Calcium binding epidermal growth factor-like containing proteins in health and disease
Professor Lars Jansen *(St. Edmund Hall)*: Mechanisms of chromatin inheritance
Professor Syma Khalid *(St. Anne's)*: The structure-dynamics-function relationships within bacterial cell envelopes
Professor Benoît Kornmann *(St Hugh's)*: Ultrastructural organisation of the cell and the biology of organelles
Professor Nick Lakin *(St. Peter's)*: Maintenance of genome integrity and DNA repair
Professor Petros Ligoxygakis *(Hertford)*: Drosophila as a model to study innate immunity
Assoc. Prof. Faraz Mardakheh *(Brasenose)*: Multi-omic studies of cancer cells
Professor Jane Mellor *(Queen's)*: Chromatin remodeling and gene regulation in simple eukaryotes
Assoc. Prof. Catherine Pears *(University)*: Cell signalling
Assoc. Prof. Anthony Roberts *(Dunn School of Pathology and Lincoln)*: Motor Proteins and intracellular organisation
Assoc. Prof. Mark Roberts *(Brasenose and Lincoln)*: Developing biochemical education
Assoc. Prof. Peter Sarkies *(Lincoln)*: Epigenetics and evolution
Professor Elena Seiradake *(Somerville)*: Molecular biology of the nervous and vascular systems
Assoc. Prof. Jason Schnell *(St John's)*: Proteins at the centre of human health and disease
Assoc. Prof. Madhusudhan Srinivasan *(Christ Church)*: Mechanisms of eukariotic chromosome seggregation
Assoc. Prof. Weston Struwe *(Worcester)*: Understanding mechanisms of host-virus interactions across molecular scales
Dr Maureen Taylor *(Exeter and Imperial College, London)*: Molecular function of sugar-binding receptors in cellular recognition events
Assoc. Prof. Stephan Uphoff *(New)*: Bacterial DNA repair and mutagenesis
Assoc. Prof. Tobias Warnecke *(Trinity)*: Evolution of molecular systems
Assoc. Prof. Alison Woollard *(Hertford)*: Molecular mechanisms controlling development and ageing in *C. elegans*

Get in touch...

The Department's website provides more information on the course, advice on applying, suggested reading as well as information about the department itself and its excellent and award winning research.

If you have any further questions regarding studying biochemistry at Oxford, please do email: admissions@bioch.ox.ac.uk

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Photo: Catalina Posada

Photo: Jeremy Rowntree

Photo: Jemma Trick

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On the cover: Combination of *in vivo*, *in vitro* and *in silico* experiments, highlighting a novel mechanism by which supramolecular assemblies control the spatio-temporal behaviour and thus the turnover of *E. coli* outer membrane proteins by Patrice Rassam (Prof Kleanthous's lab).
Background image on this page: Cre synaptic complex, by Pawel Zadwaski (Prof Sherrat's lab). Petri dish tower image by Patrice Rassam.
Other photos / production by Juan Escobar and Patricia Hook.