WHTC University application subject guides

Biomedical Science/Biochemistry

This guide has been written to help support you in your application to university. It contains the following information relevant to your subject to help you decide where to apply and put together the best application that you possibly can:

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1. Course links

Below are links to the top courses for this subject in the UK (according to The Complete University Guide). Click on the links to find information about what the course is like, what you'll learn, and loads of information about things such as fees and accommodation. However, remember that there are loads of other great universities out there, so check out The Complete University Guide or just google studying your subject at university.

1. University of Cambridge (Natural Sciences BA)
2. University of Oxford (Biomedical Science BA)
3. UCL (University College London) (Biochemistry, Biomedical Science BSc)
4. Imperial College London (Biochemistry, Medical Biosciences BSc)
5. King's College London (Biochemistry, Biomedical Science BSc)

6. University of Manchester (Biochemistry, Biomedical Science BSc)
7. University of Bristol (Biochemistry, Biomedical Science BSc)

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2. Entrance requirements

Here are the grades that the university suggests you need to get in to that course, and the likely offer that they will give you.

1. Cambridge: A* A* A (to include A levels in at least two Science/Mathematics subjects)
2. Oxford: A* A A
3. UCL: A A A (subjects should include A level Biology, Chemistry and Mathematics)
4. Imperial College London: A A A (must include: A in Chemistry A in Biology, Physics or Mathematics)
5. King's College London: A A B (must include Biology and Chemistry)
6. University of Manchester: A B B (including two of Biology, Chemistry, Physics and Maths)
7. University of Bristol: A B B or A A C (including Chemistry and another core science/mathematics subject)

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3. Recommended A-levels

Different universities may differ as to what A-levels they ask you for. Some might list one subject as 'essential', while another might list the same subject as just 'helpful', so make sure to check out the course page (under Section 1 of this document, or on the university website) to be sure what your chosen university expects!

Many universities state that you must have studied both Biology and Chemistry as A level courses in order to apply for Biomedicine and Biochemistry courses at University.

It is also recommended to have studied Physics or Maths at A level, although not essential.

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4. Admissions tests

What admissions tests are you typically required to sit in addition to submitting your application? This also differs from uni to uni, so if your chosen university isn't on this list, make sure you check out the course page so you know exactly what you need to apply.

Cambridge: pre-interview written assessment

Oxford: BMAT (Biomedical Admissions Test)

UCL: none

Imperial: none

King's College London: none

Manchester: none

Bristol: none

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5. Recommended reading

Reading some relevant books or articles is a really great way to demonstrate your passion for your chosen subject in your personal statement, and show how you've gone beyond the curriculum. Plus, if you really want to spend three years or more studying this subject at university, it should be enjoyable! Try taking notes and jotting down your thoughts as you're reading so that you can share some of this in your personal statement

General scientific magazines and publications

Nature – www.nature.com
Free to access articles

Nature is a British multidisciplinary scientific journal, first published on 4 November 1869. It is one of the most recognizable scientific journals in the world, and was ranked the world's most cited scientific journal by the Science Edition of the 2018 *Journal Citation Reports* and is ascribed an impact factor of 43.070, making it one of the world's top academic journals.

New Scientist – www.newscientist.com
Free to access articles

New Scientist, first published on 22 November 1956, is a weekly English-language magazine that covers all aspects of science and technology. Based in London, it publishes editions in the UK, the United States, and Australia. Since 1996 it has been available online.

Discover – www.discovermagazine.com
Free to access articles

Discover is an American general audience science magazine launched in October 1980 by Time Inc.

Science - https://www.sciencemag.org
Free to access scientific articles

Science, also widely referred to as Science Magazine, is the peer-reviewed academic journal of the American Association for the Advancement of Science and one of the world's top academic journals.

National Geographic - https://www.nationalgeographic.com
Some free to access scientific articles

National Geographic (formerly the ***National Geographic Magazine*** and branded also as **NAT GEO**) is the official magazine of the National Geographic Society. It has been published continuously since its first issue in 1888, nine months after the Society itself was founded. It primarily contains articles about science, geography, history, and world culture.

General scientific journals

eLife - https://elifesciences.org/
Free to access peer-reviewed journals

eLife is a peer-reviewed open access scientific journal for the biomedical and life sciences.

Bioessays - https://onlinelibrary.wiley.com/journal/15211878
Some free to access peer-reviewed journals

BioEssays is a monthly peer-reviewed review journal covering molecular and cellular biology. Areas covered include genetics, genomics, epigenetics, evolution, developmental biology, neuroscience, human biology, physiology, systems biology, and plant biology. The journal also publishes commentaries on aspects of science communication, education, policy, and current affairs.

Cell – www.cell.com
Free to access peer-reviewed journals

Cell is a peer-reviewed scientific journal publishing research papers across a broad range of disciplines within the life sciences.

Recommended books

The Selfish Gene by Richard Dawkins

As relevant and influential today as when it was first published, The Selfish Gene has become a classic exposition of evolutionary thought. Professor Dawkins articulates a gene's eye view of evolution - a view giving centre stage to these persistent units of information, and in which organisms can be seen as vehicles for their replication.

The Emperor of All Maladies by Siddhartha Mukherjee

In The Emperor of All Maladies, Siddhartha Mukherjee, doctor, researcher and award-winning science writer, examines cancer with a cellular biologist’s precision, a historian’s perspective, and a biographer’s passion. The result is an

astonishingly lucid and eloquent chronicle of a disease humans have lived with - and perished from - for more than five thousand years.

The Gene: An Intimate History by Siddhartha Mukherjee

In this book the author spends time carefully chronicling the story of genetics while including bits of his own personal history with hereditary illness, the “intimate” history suggested by the subtitle. He places the gene in a trilogy of scientific ideas that dominated the twentieth century, alongside the atom and the byte.

Gene Machine: The Race to Decipher the Secrets of the Ribosome by Venki Ramakrishnan

Everyone knows about DNA, the essence of our being, the molecule where our genes reside. But DNA by itself is useless without a machine to decode the genetic information it contains. The ribosome is that machine. Nobel Prize winner Venki Ramakrishnan tells the story of the race to uncover its enormously complex structure, a fundamental breakthrough that resolves an ancient mystery of life itself.

The Immortal Life of Henrietta Lacks by Rebecca Skloot

Her name was Henrietta Lacks, but scientists know her as HeLa. She was a poor black tobacco farmer whose cells—taken without her knowledge in 1951—became one of the most important tools in medicine, vital for developing the polio vaccine, cloning, gene mapping, and more. Henrietta’s cells have been bought and sold by the billions, yet she remains virtually unknown, and her family can’t afford health insurance. This phenomenal New York Times bestseller tells a riveting story of the collision between ethics, race, and medicine; of scientific discovery and faith healing; and of a daughter consumed with questions about the mother she never knew

The Epigenetics Revolution by Nessa Carey

How is it that, despite each cell in your body carrying exactly the same DNA, you don't have teeth growing out of your eyeballs or toenails on your liver? How is it that identical twins share exactly the same DNA and yet can exhibit dramatic differences in the way that they live and grow? It turns out that cells read the genetic code in DNA more like a script to be interpreted than a mould that replicates the same result each time. This is epigenetics and it's the fastest-moving field in biology today. The Epigenetics Revolution traces the thrilling path this discipline has taken over the last twenty years.

Hacking Darwin by Jamie Metzl

At the dawn of the genetics revolution, our DNA is becoming as readable, writable, and hackable as our information technology. But as humanity starts retooling our own genetic code, the choices we make today will be the difference between realizing breathtaking advances in human well-being and descending into a dangerous and potentially deadly genetic arms race.

Enter the laboratories where scientists are turning science fiction into reality. Look towards a future where our deepest beliefs, morals, religions, and politics are challenged like never before and the very essence of what it means to be human is at play. When we can engineer our future children, massively extend our lifespans, build life from scratch, and recreate the plant and animal world, should we?

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6. Interesting MOOCs

Another great way of learning more about your chosen subject and demonstrating your interest is to take a MOOC, or Massive Open Online Course. These are free courses delivered by universities that you can take online. If the ones below don't take your fancy, try looking at Class Central - they have a huge list of different courses for every subject imaginable, and they're all free!

Edx - https://www.edx.org/learn/biology

Free courses to further your knowledge and understanding of Biology

edX is a massive open online course provider. It hosts online university-level courses in a wide range of disciplines to a worldwide student body, including some courses at no charge.

Medical Neuroscience (Duke University)

Medical Neuroscience explores the functional organization and neurophysiology of the human central nervous system, while providing a neurobiological framework for understanding human behavior. In this course, you will discover the organization of the neural systems in the brain and spinal cord that mediate sensation, motivate bodily action, and integrate sensorimotor signals with memory, emotion and related faculties of cognition.

Introductory Human Physiology (Duke University)

In this course, students learn to recognize and to apply the basic concepts that govern integrated body function (as an intact organism) in the body's nine organ systems.

Biochemistry: Biomolecules, Methods and Mechanisms (MIT Massachusetts Institute of Technology)

Do you want to prepare for medical school, study a STEM field, become a research scientist, or transition to a career in the booming biotechnology industry? Or maybe you just want to understand the chemical reactions that govern life itself. Join Professor Yaffe, an MIT professor and practicing surgeon, as he guides you through the science that inspires countless doctors, researchers, and students alike.

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7. Useful additional resources

There are loads of other great things out there that you might want to look at to develop your interest and strengthen your application, from videos to podcasts, to websites. Here are a few suggestions:

Staircase 12: https://www.univ.ox.ac.uk/applying-to-univ/staircase12/
TED talks: https://www.ted.com/topics/biomechanics
Podcasts:

- Stuff you missed in history has some good medical history episodes
- This podcast will kill you (infectious diseases)
- Bedside Rounds (medical history)

Websites:

- Becoming a Dr – free resource aimed at aspiring and current UK-based students. Sign up for access to free webinars and resources https://www.becomingadr.org/aspiring/
- Free course on how the NHS works: https://www.futurelearn.com/courses/the-nhs-explained
- Free Open University courses: https://www.open.edu/openlearn/science-maths-technology/science/biology

8. Related courses

At university, there are loads of different combinations of subjects that you can do. Maybe you might find one of these alternatives more interesting? A few ideas are listed below with a sample link, but in most cases there are lots of universities that offer these different combinations so make sure to have a good look around!

There are often combination University courses which offer Biomedical Science or Biochemistry with a foreign language, or some that offer a Year in Industry (work experience for a year). There are also some courses which allow you to continue your studies onto a Masters degree. These are indicated by an MSc notation and will be 4 year courses.

In addition, other similar offered courses are the following:

- Biochemistry with a Modern Foreign Language (French, German, Spanish)
- Biological Sciences

- Biochemical Engineering
- Biomaterials and Tissue Engineering
- Biotechnology
- Cancer Biomedicine
- Ecology and Environmental Biology
- Human Sciences
- Infection and Immunity
- Medical Biosciences
- Molecular Genetics
- Microbiology
- Neuroscience
- Pharmacology
- Physics with Biophysics

Many universities operate a ‘common year one’ where compulsory modules are taught and shared across many of the above listed courses. This allows you the option to easily swap your degree course in your second year if you so desire, where you will then begin to specialise and refine your speciality based on your degree choice.

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9. Oxbridge example interview questions

As you will know, applicants to Oxford and Cambridge have to take an interview in order to get a place. It is normal to get open-ended questions, as well as being given charts or pieces of writing to analyse. Here is a sample of the kind of questions you might get asked. Remember, you’re supposed to not know the answer! They often deliberately choose topics that they think no one will have studied in order to make the questions fair. What they’re looking for is to see how you think under pressure, and how you can present your ideas and your logic.

Below are a short snapshot of the variety of questions which have been asked in previous interviews for Oxford University. These have been taken from the university website.

- How do amino acids behave in both acidic and basic conditions?
- What is the significance of the human genome project?
- How does DNA fingerprinting work? What is its use?
- Why are there so many steps in the cascade of reactions
- How do you tell if a protein codes for a transmembrane protein?
- Why are there only twenty amino acids?
- What shape are bacteria and why?
- What are the arguments for preserving biodiversity?
- What makes drugs physiologically active?
- For which disease do you think it is an advantage to be a carrier of sickle cell anaemia?
- Explain the differences between bacteria and viruses
- What are the issues with using phylogeny?
- Why is water so important to life?
- What is the significance of the human genome project?
- Why are there so few large predators?

Why is sugar in your urine a good indicator that you might have diabetes?

This question builds on general knowledge and material studied at school in biology and chemistry to assess how students approach a clinically-relevant problem. It's commonly known that diabetes is associated with sugar (glucose) in the urine; this question asks students to think about why this occurs. Students have usually have learnt that the kidneys filter blood to remove waste products, such as urea, that must be eliminated from the body but many other useful substances which must not be lost – including glucose – are also filtered. Given that glucose is not normally found in the urine, students are asked to speculate as to how it can all be recovered as the urine passes through the kidney's tubules.
The process involves reabsorption by a carrier protein that binds the glucose molecules and moves them out of the renal tubule and back into the blood. Students should appreciate that, in binding glucose, the carrier will share properties with enzymes, about which they will have learned at school: the capacity to reabsorb glucose is finite because once all of the carriers are working maximally, no further glucose reabsorption can occur. A successful applicant will make the connection that an elevated level of glucose in the blood in diabetes leads to increased filtration of glucose by the kidneys and saturation of the carriers that perform the reabsorption, resulting in 'overspill' of glucose in the urine.

Why do a cat's eyes appear to 'glow' in the dark?

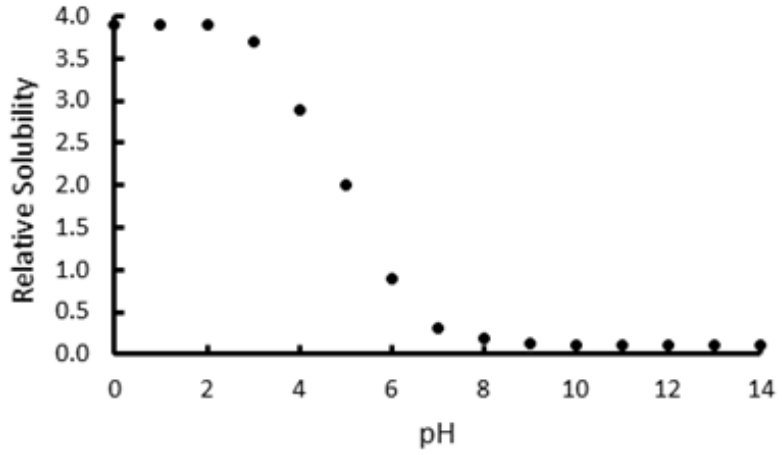
This question builds on commonly held knowledge and on material covered in Biology at school about visual processes. The question assesses criteria such as scientific curiosity (has the applicant ever wondered this themselves? Have they formulated any theories?) and scientific reasoning, based on information provided by the interviewer as the interview progresses. After establishing that the applicant understands that light is detected by photoreceptors in the eye (and exploring and

explaining this concept if it is a new one), the discussion would consider how the glow might be advantageous to the cat, seeing whether the applicant can appreciate that it may help the animal to see in the dark. Possible explanations for the glow would be discussed with an expectation that applicants might recognise that the light could be generated within the eye or alternatively that light entering the eye is in some way reflected back out. Having established the second possibility as more being more plausible, the interviewer would probe to see whether the candidate recognises the significance of giving photoreceptors two chances to capture light as rays pass into and then out of the eye and why at night this might enhance vision.

Would you expect this compound to be more soluble in octanol or water? (The student will be shown the structure of an organic compound with functional groups that they will be familiar with from A-level/IB studies)

We do not expect the student to know the answer to this question straight away, and in fact getting the correct answer isn't important here. It is more useful for us to see how the candidate applies their chemical knowledge to a problem they are unlikely to have considered before, how they justify their conclusions and whether they are capable of considering alternative possibilities.
If a student struggles with a starting point we would prompt them to describe more generally the different kinds of interactions that hold molecules together and to comment on their relative strength. We would then encourage them to think about what interactions the specific compound might make first with octanol and then with water. A good approach to answering the question would be to first consider the individual functional groups separately and then to discuss the compound as a whole.
The extension to this question asks the student to interpret some graphical data and requires a more technical introduction. We are careful at this point to make sure that the student has understood the explanation before moving forward with the question.

The relative solubility of a compound in octanol vs aqueous solution can be determined by putting a sample of the compound in a 1:1 mixture of octanol and aqueous solution and then measuring the concentration of the compound that has dissolved in each of the solvents. For one particular compound the relative solubility varies with pH as shown in the graph below. Can you interpret this graph?



$$\text{Relative solubility} = \log_{10}\left(\frac{\text{Concentration of compound dissolved in octanol}}{\text{Concentration of compound dissolved in aqueous solution}}\right)$$

We would clarify the compound discussed here is different to the one in the first part of the question and that 'aqueous solution' means water with acid or base added to control the pH.

The aim of this question is to see whether the student can understand a new concept and apply it to a problem. One approach to this question is to first consider the flat regions of the graph. Between pH 0 and 4 the compound has a relative solubility very close 4. The student can use the equation to work out that this corresponds to much more of the compound dissolving in octanol than in water. In contrast, between pH 9 and 14 the relative solubility of approximately zero corresponds to almost equal concentrations of the compound dissolving in octanol and water. The student then needs to consider how the structure of a compound might change as pH is varied. If they struggle at this point we might give a specific prompt, for example, "What form would you expect a water molecule to be found in at low pH?". Ultimately the prompts lead to the idea that the charge of a compound can change with pH due to gain or loss of hydrogen ions.

The graph shown here corresponds to a compound where the vast majority of the molecules are neutrally charged between pH 0 and 4. As the pH is raised a greater proportion of the molecules will lose a hydrogen ion to become negatively charged, being charged reduces the solubility in octanol and so the relative solubility decreases. The plateau region above pH 9 occurs because almost all of molecules have lost the hydrogen ion by this point. Although the compound becomes negatively charged, it does not become more soluble in water than octanol, this suggests that the compound also includes functional groups that interact well with octanol, such as alkyl chains or rings. It is important to note that a student would not have to make all of these points to do well in the interview.