

CAREERS THROUGH MATHS: BIOLOGIST



JOB DESCRIPTION

A Biologist in the UK applies the principles of life sciences to understand living organisms, from microscopic bacteria to complex ecosystems like the Scottish Highlands. Their work is highly varied, encompassing research in laboratories, fieldwork across the British countryside, and roles in industry and regulation. A typical day might involve designing an experiment to test a new pharmaceutical compound at a research facility in the Golden Triangle (London, Oxford, Cambridge), collecting and analysing water samples from a river in the Lake District to monitor pollution, or using ecological models to advise a construction company on minimising the environmental impact of a new infrastructure project.

The core duties of a Biologist are deeply analytical. They are responsible for formulating hypotheses, planning and executing complex experiments, and rigorously interpreting the resulting data. For instance, a microbiologist at a UK water treatment plant, such as those operated by Thames Water or Scottish Water, must routinely culture and count bacterial colonies to ensure water safety, requiring precise calculations of dilution factors and statistical analysis to confirm compliance with strict Drinking Water Inspectorate standards. Similarly, a marine biologist with the Marine Management Organisation or a consultancy like APEM Ltd might use sonar and GPS data to map seabed habitats, applying geometric principles to calculate areas and assess the health of marine protected areas.

Mathematics is not merely a supplementary tool but is central to the role of a modern Biologist. It provides the framework for transforming qualitative observations into

quantitative, evidence-based conclusions. Whether modelling the spread of an invasive species like the Asian hornet in Southern England, calculating the correct dosage of a reagent in a diagnostic lab within the NHS, or performing a statistical test to determine if a change in a species' population is significant, mathematical competence is fundamental. This rigorous, data-driven approach is what allows UK biologists to contribute to critical sectors, from healthcare and agriculture to environmental conservation and biotechnology.

HOW MATHEMATICS IS USED

- **Statistics and Data Analysis:** This is the cornerstone of biological research. Biologists use statistics to determine if the results of their experiments are meaningful or due to chance. For example, a researcher at the Pirbright Institute might use a t-test to compare the immune response in two groups of cattle vaccinated with different formulations. In the pharmaceutical industry, a biostatistician at AstraZeneca would use complex regression models to analyse clinical trial data, determining the efficacy and safety of a new drug. Ecological consultants regularly use biodiversity indices, such as the Simpson's Index, to quantify species diversity at a proposed development site for a preliminary ecological appraisal.
- **Mathematical Modelling:** Biologists construct models to simulate complex biological systems and predict future outcomes. An epidemiologist at Public Health England might use SIR (Susceptible, Infected, Recovered) models to forecast the spread of an influenza outbreak and inform vaccination strategies. In conservation, biologists at the Royal Society for the Protection of Birds (RSPB) use population viability analysis (PVA) models to predict the long-term survival chances of endangered species like the capercaillie, helping to prioritise conservation efforts. Agri-tech companies use growth models to predict crop yields under different climate scenarios.
- **Calculus:** The principles of calculus are essential for understanding rates of change, which are ubiquitous in biology. A pharmacologist studying the pharmacokinetics of a drug needs to use differential equations to model how the concentration of the drug in the bloodstream changes over time. In physiology, integral calculus is used to calculate total cardiac output from blood flow rates.

An ecologist might use derivatives to model the instantaneous growth rate of an algal bloom in a reservoir.

- **Bioinformatics and Computational Biology:** This field involves developing and applying computational tools to analyse large biological datasets, such as DNA sequences. A bioinformatician at the Wellcome Sanger Institute uses algorithms and probability theory to identify genetic variants associated with diseases from vast genomic datasets (e.g., UK Biobank). They also use linear algebra in multiple sequence alignment to compare genes across different species, which is fundamental to understanding evolution and function.
- **Biometry and Geometry:** Biometry involves applying statistical methods to biological data for measurement and comparison. For example, a wildlife biologist might use regression analysis to study the relationship between the wing length and body mass of birds. Geometry is used in morphology to quantify the shape of organisms, such as using fractal geometry to analyse the complex branching patterns of lungs or coral colonies, or in forestry to calculate tree canopy cover from aerial imagery.

KEY SKILLS & TOOLS

Skill/Tool	Application
R and Python	Used for the vast majority of statistical analysis and data visualisation in research and industry. A biologist at the Centre for Ecology & Hydrology would use R to perform a complex generalised linear model (GLM) to analyse how butterfly population trends are affected by climate variables. Python is used for scripting complex bioinformatics pipelines to analyse next-generation sequencing data.
GraphPad Prism & SPSS	Industry-standard software for statistical analysis, particularly in pharmaceutical and clinical settings. A research scientist at GSK would use GraphPad Prism to quickly perform ANOVA tests and create publication-quality graphs from experimental data on drug efficacy. SPSS is widely used in social and ecological sciences for survey data analysis.

GIS (Geographic Information Systems)	Software like QGIS or ArcGIS is used to analyse spatial biological data. An ecologist at an environmental consultancy like Jacobs or RSK would use GIS to map protected species sightings, model habitat suitability, and calculate the area of impact for a new road development, requiring geometric calculations and spatial statistics.
Laboratory Information Management Systems (LIMS)	Digital systems used in commercial and healthcare labs (e.g., within the NHS or Eurofins) to track samples and manage associated data. Biologists use them to log sample metadata, ensuring data integrity and enabling the calculation of key metrics like sample throughput and assay success rates for quality control.
PCR & Sequencing Technologies	The polymerase chain reaction (PCR) relies on precise exponential growth mathematics (2^n) to amplify DNA. Next-generation sequencers generate terabytes of data, which bioinformaticians process using probabilistic models and algorithms to accurately reconstruct genomic sequences, a core activity at institutes like the Earlham Institute.
Scientific Writing & Data Visualisation	The ability to clearly present complex mathematical results is crucial. Biologists must write detailed reports for regulators like the Environment Agency, present statistical findings to non-scientific stakeholders, and create clear data visualisations for publications in journals like Nature.
Quality Assurance & Control (QA/QC)	Adherence to strict standards like UKAS (United Kingdom Accreditation Service) and GLP (Good Laboratory Practice) is mandatory. This involves using statistical process control charts to monitor the precision and accuracy of laboratory equipment, ensuring all data generated is reliable and auditable.

Typical Pathway: The most common route begins with strong GCSEs (or National 5s in Scotland) in Sciences and Mathematics, followed by A-levels (or Scottish Highers) in Biology, Chemistry, and Mathematics. A bachelor's degree (BSc) in a biological science from a recognised university, often with an accredited pathway by the Royal Society of Biology (RSB), is essential. Graduates often start in entry-level roles such as Research Assistant, Laboratory Technician, or Ecological Consultant. Career progression involves specialisation, with many pursuing a postgraduate Master's (MSc) or PhD for advanced research roles. Gaining Chartered Biologist (CBiol) status with the RSB is a key qualification that demonstrates a high level of professionalism.

and competence and is highly valued by UK employers for senior positions. Continuous professional development (CPD) is maintained through institutions like the Society of Biology.

Industry Demand: The UK job market for biologists is robust, driven by growth in the life sciences and environmental sectors. The UK government has identified the Life Sciences sector as a key economic priority, with significant investment in regions like the Oxford-Cambridge Arc. The Office for National Statistics projects growth in scientific and technical activities. Demand is particularly strong in bioinformatics, environmental consulting (driven by net-zero targets and biodiversity net gain legislation), and pharmaceutical R&D, all of which require strong mathematical and data analysis skills.

Real-World Impact: Biologists are at the forefront of tackling some of the UK's biggest challenges. They played a critical role in the COVID-19 pandemic through genomic sequencing and modelling at institutions like the Wellcome Sanger Institute and Public Health England. Ecologists ensure major UK projects like High Speed 2 (HS2) comply with environmental law, protecting native wildlife. Furthermore, biologists in the agri-tech sector work with companies like Rothamsted Research to use statistical models for developing sustainable farming practices, directly contributing to UK food security and environmental conservation.