Anglia Ruskin University

Course Information Sheet

BSc (Hons) Zoology

Mode and course length – Full-Time (4 years)

Location – ARU Cambridge Campus

Awarding Body – Anglia Ruskin University. As a registered Higher Education provider Anglia Ruskin University is regulated by the Office for Students.

Overview

Immerse yourself in the lives and behaviour of animals on our Society of Biology-recognised degree. You'll study in a world-renowned centre of wildlife conservation, and get practical skills in our laboratories that you can apply on a range of field trips in the UK and abroad.

If you're interested in a career exploring and understanding the lives of animals, you'll be in good company – alongside Charles Darwin, Dian Fossey, Jane Goodall and David Attenborough.

Zoology is closely connected to subjects such as cell biology and genetics. You could choose to specialise in areas such as animal behaviour, wildlife biology or ecology and conservation.

Field work is an important part of zoology. It's a practical subject and we'll give you plenty of opportunities to learn and practise both in the lab and the field. In your second year you'll take a week-long field trip to north Devon to experience both marine and terrestrial zoology, the costs of which are included in your course fees. On our optional field trips you might experience rutting red deer on the island of Rum; marine biology in Scotland; world-class zoos in the Netherlands; wildlife and ecology in Africa; and diving and marine biology overseas. You'll need to pay for these optional trips.

Cambridge is becoming a world centre for wildlife conservation, with Fauna and Flora International, Birdlife International and the World Conservation Monitoring Centre based here. You'll have opportunities to attend lectures and visit specialist museums and libraries in the city. If you're interested in captive animal behaviour, you can access the facilities at the College of West Anglia, Cambridge.

Course Delivery

Our courses are delivered through teaching and learning methods which provide students with the widest possible exposure to a modern and innovative higher education experience.

These methods vary and could include attendance at lectures and seminars, undertaking laboratory exercises or work-based activities, practical work, performances, presentations, field trips, other relevant visits and e-learning through Canvas, our online learning management system.

Each course is divided into a number of 'modules' which focus on particular areas, each of which has a specific approach to its delivery. This information is published to students for each module they take via the Module Definition Form (MDF) and Canvas.

Assessment

Throughout the course, we'll use a range of assessment methods to help you measure your progress. Besides exams, these include essays, practical reports, computer-based assessments, presentations, debates, classroom- or laboratory-based tests, and reviews of scientific papers.

Fees

Information about your course fee including any annual fee increases or deposits (if required) can be found in your offer letter.

Additional Costs

Walking boots - £60

Waterproof coat - £50

Wellingtons - £25

Waterproof trousers - £20

Poster printing - £20

Cost of printing dissertation/individual project

Additional field trip costs on optional modules

Isle of Rum field trip - £250 approx

International Diving trip - £950 approx

Netherlands Zoo Trip - £350 approx

Uganda field trip two weeks (Tropical Ecology and Management) - £1750 approx

Millport Marine Trip - £450 approx

Modules

Core Modules

Year 1: Foundation in Optometry, Medical and Life Sciences

This module will provide students with the necessary skills to begin studying at level 4 in courses related to Optometry, Medical Science and Life Sciences.

Students will be introduced to the core skills necessary to succeed in higher education, including thinking critically, researching and referencing appropriately, demonstrating appropriate numeracy and ICT skills, and communicating effectively verbally and in writing.

In addition to these fundamental study skills, Students will be given an introduction to the various scientific disciplines underpinning the life sciences. Fundamental mathematical skills will be covered in order to support students' other subjects and give them confidence in manipulating data.

Students will be introduced to molecular and cellular biology, and how these fields are applied to real-world investigations. Students will also study the biology of micro and macro organisms, with reference to both human and animal structures.

Students will be introduced to the core concepts of chemistry, with a particular focus on organic chemistry, and will also be given a grounding in the core principles of physics, applied to living organisms.

The module is made up of the following 8 constituent elements:

- Interactive Learning Skills and Communication (ILSC)
- Information Communication Technology (ICT)
- Critical Thinking
- Maths for Scientists
- Cellular Biology
- Biology – Physiology
- Chemistry

- Physics for Life Sciences

Year 2: Origins of Life

The origin of life on earth is one of the great mysteries of our age. It is of special interest to biologists, as it addresses the fundamental question of where we (and all other living things) came from. This module will begin with a philosophical exploration of the meaning of life and the role of science in exploring life (i.e., biology). We will discuss different interpretations of life through time, across cultures, and through academic disciplines and consider some basic background in history of science and philosophy of science.

The module will give students an introduction to geological time, the origins of the planet Earth and changing environmental conditions (e.g., climates). It will then ask questions such as: When did life originate? Where did life originate? How did life originate? We explore the methods that modern biologists use for asking questions about the origins of life, and the different hypotheses about how life may have evolved from simple organic molecules (and whether life originated on Earth, or whether it may have been 'seeded' from elsewhere). We will discuss the major transitions in evolution, including the origins of replication, cell membranes, metabolic processes, multicellularity, sexual reproduction, the colonization of land and the emergence of plants, invertebrates and vertebrates (including the K/T boundary and the Cambrian explosion). Most will be translated into practical skills, laying the foundation for a career as a student/scientist in the biological sciences. At the end of the module you will feel comfortable and be competent using basic and some advanced laboratory and biological field skills.

Year 2: Introduction to Marine Biology

This module introduces you to the range of marine environments and marine life within the biosphere - and the factors which generate this variety. It provides the basis for studying other 'marine' modules at Levels 5 and 6. The course will cover aspects of the biology, ecology and environmental physiology of selected marine organisms around the UK shores and beyond. The module will involve an optional full day field trip to a coast in East Anglia to study plant and animal life at the interface of land and sea. This field trip will require a certain amount of walking over rough terrain.

Year 2: Introduction to Wildlife and Conservation

This module provides an introduction to wildlife taxonomy, conservation, distribution and ecology, with a focus on vertebrates found in Britain (key taxonomic groups studied are birds, mammals, amphibians and reptiles). For each major taxonomic group and for selected individual species, key conservation and management issues are addressed.

You will also consider historical changes in the distribution and abundance of wildlife, and learn to assess the problems and challenges posed by both re-introductions and by the release/introduction of non-native species. The module includes a laboratory-based practical session (e.g. on identifying tracks and signs). There is a field trip (day trip) to a grey seal colony during the main breeding season.

By taking this module you will acquire basic skills and knowledge relevant to a range of careers in ecology, conservation or wildlife biology.

Year 2: Introduction to Animal Behaviour

In this module the philosophy and multidisciplinary origins of the scientific study of behaviour are reviewed. The ethically sound use of the scientific study of animal behaviour in pure and applied disciplines will be considered, especially in the context of the assessment of animal welfare. Differences in the emphases between the fields of psychology and animal behaviour are discussed, with particular reference to the learning process, and the synthesis of these fields is presented using a framework of proximate (developmental and mechanistic) and ultimate (functional and phylogenetic) explanations. Fundamental processes influencing animal behaviour will be considered, including the relative contributions of evolutionary processes, gene expression and environment in the elucidation of behaviour, and how the structures and processes of the nervous system underpin the biological bases of behaviour. You will be an introduced to the appropriate scientific framing of questions and hypotheses as a starting point for the scientific investigation of behaviour; and basic techniques for describing and recording behavioural observations. Through this module you will gain foundation knowledge in the scientific study of animal behaviour and its potential applications and the principles of sound experimental design. Such skills will be developed in subsequent modules and will prove useful in a wide range of scientific and animal management careers.

Year 2: Animal Form and Function

The ways in which animals cope with the demands of everyday life, from feeding, moving and respiring to sensing the outside world and each other are as diverse as the animals themselves. This module will examine the variety of ways in which an animal's anatomy and physiology are adaptations to the many tasks it faces to survive. Particular emphasis will be placed on comparing the solutions evolved to similar tasks by various animal groups such as insects and other invertebrates, fish, amphibians, reptiles, birds and mammals. For example: What is the difference between how a fish and a heron feed? What is it about the ruminants' digestive systems that makes them (cattle, antelope, goats, etc.) a more diverse group than non-ruminants (horses, tapirs and rhinos)? Through a series of integrated lectures and practical classes this module will comparatively examine the main themes of feeding methods, alimentary systems, respiration, circulation, homeostasis, internal communication, locomotion, sensory systems and external communication. This module's aim is to provide the foundation knowledge to the study of animal physiology and how it relates to the ecology of the species concerned. Such skills will be developed in subsequent modules and will prove useful in a wide range of biological careers. You will have access to both virtual and real learning resources. Lectures will form two thirds of the teaching, with the remainder of the taught time spent in practical classes, enabling you to explore and examine aspects of the topics covered in a variety of different ways. Students will also be taught elements of Good Laboratory Practice.

Year 2: Evolution and Biodiversity

This first year course is compulsory for all students on Animal Behaviour, Zoology and Marine Biology with Biodiversity & Conservation courses. It will introduce you to the major principles of evolutionary theory and highlight the major transitions that have occurred in the diversification of life. It will also consider the limitations on evolutionary possibility that come from physical and historical constraints.

The course will begin by focussing on the early events in evolution, including the origin of life, the symbiotic creation of the eukaryotic cell, and the advent of multicellularity. It will go on to investigate the challenges and opportunities that multicellular life forms had to face and how these were met in different ways by the major kingdoms. We will then discuss the processes that led to diversification in some groups, with an emphasis on the theories and mechanics of speciation. We will finish the course by focussing on the problematic concept of evolutionary “success” and consider some key innovations that allowed organisms to reach previously unexplored regions of theoretical morphospace.

A range of activities will enhance your understanding of evolutionary processes and extant biodiversity. Throughout the course, you will be asked to integrate evidence based upon conditions on the early Earth, genetic analysis, and the morphology/physiology of extant life-forms. You will learn how to interpret microbial, plant, fungal and microbial diversity via and microscopy. You will learn how to diagnose particular groups of organisms using diagnostic keys and develop your own diagnostic keys. You will experiment with evolutionary models from the movement of alleles to constructing cladograms and evolutionary networks. The course will also involve off-site visits to a botanical garden, geology and zoology museum.

Year 2: Ecology

The aim of this module is to provide a broad introduction to animal and plant ecology and facilitate the study of ecological modules at higher levels. The module introduces you to ecological terminology, the scope of ecology and the potential role of ecological science in providing guidance on the sustainable use of the biosphere. You will be introduced to a range of biotic (eg predation, parasitism) and abiotic factors (e.g. conditions like temperature and resources such as nutrients) which control the distribution and abundance of organisms. The types of interactions between organisms and the concept of ecological niche will be discussed. There will also be reference to ecosystem processes in relation to the trophic structure of ecosystems and flows of energy. Techniques for investigating the distribution, abundance and tolerance of organisms will be introduced in laboratory and field exercises. Two field trips are normally an integral part of the module and are linked to exercises. These trips may require attendance outside the timetabled slot for the module, which may include a weekend attendance. Both trips require a limited degree of physical fitness. The module contributes to a portfolio of skills related to employment in the area of Ecology.

Year 2: Biomeasurement

Develop your statistics and computer software skills while focussing on the area bioscience, gaining quantitative and IT skills

that are applicable to a wide range of graduate employment opportunities. You are shown how to use information, or data, to answer questions about biological systems. You gain knowledge of a range of visual and statistical techniques and the ability to use spreadsheet (Microsoft Excel) and statistical software (R and SPSS) to carry them out. You're shown how to: (1) choose the appropriate technique for a range of data types and circumstances; (2) perform and interpret analyses correctly; and (3) communicate the results of these analyses honestly and clearly. You'll use this software to produce a variety of graphs, manipulate data and calculate descriptive statistics, learning how to present data and carry out descriptive and inferential statistical, a variety of inferential statistical procedures. The inferential statistical procedures cover both estimation and null hypothesis significance testing (NHST), covering parametric and nonparametric procedures for datasets involving up to two variables (e.g., chi-squared test, t-test, Wilcoxon matched-pairs test, one-way Anova, regression, correlation). You'll participate in small-group tutorials and with hands-on computer practical sessions, with an emphasis on the use of real datasets and examples of the presentation of results in the scientific literature throughout.

Year 2: Personal and Professional Development – Level 4

At Anglia Ruskin University we strive to ensure that students receive an outstanding academic education and student experience and understand that, whilst embedding employability skills within the credit-bearing curriculum is important, it is only part of the set of achievements needed in order to obtain career employment.

This 0-credit module will be used to track and verify the progress students have made with respect to key employability skills and endeavour. Students will work closely with their personal tutor, SU Volunteering Service, Study Skills Plus, and the Faculty Employability Advisor to engage with co-curricular and extracurricular opportunities and activities to enhance their personal attributes.

Year 3: Invertebrate Biology

Invertebrates account for over 99 % of all animal species. It is estimated that the total number of animal species on Earth may exceed 30 million although only around 1 million have been named. In this module we introduce the diverse world of invertebrates focussing on aspects of their biology, ecology and behaviour. There is an emphasis in parts of the module on classification and identification of invertebrates using a range of techniques. Coverage of structural biology leads on to physiological functioning and consideration of adaptations that allow invertebrates to fill a range of specialised ecological niches. The major impacts which invertebrates have on both natural and man-made ecosystems will lead into applied areas, such as the impact of insect pests in agriculture. We will also consider various other aspects of invertebrate biology, such as their role in decomposition, social insects, insect-plant interactions, pollination and their survival in extreme environments. Since most invertebrate species remain to be discovered anyone equipped with a few basic observational and experimental skills can make a significant contribution to this fascinating area of science. Field and laboratory based practical sessions are a critical component of this module.

Year 3: Vertebrate Biology

The vertebrates account for fewer than 1% of known species of animal life. Yet the vertebrates (including humans) are some of the most successful and widely adapted animals on Earth. Vertebrates inhabit almost all corners of our planet, except the deepest parts of the oceans, close to the poles and on top of the highest mountain peaks. Vertebrate species may be terrestrial, arboreal or marine; they burrow, swim, run, climb, fly or glide. They include the so called "charismatic megafauna" such as tigers, eagles, elephants and pandas, as well as top predators such as sharks and crocodiles. Vertebrate Biology is the study of how these animals came to occupy their current dominant position among animal life on Earth. The core of this module is the study of the evolution, structure and function of the modern vertebrates. Comparative anatomy and physiology of the vertebrates are studied within a taxonomic framework. The module traces the evolutionary history of the different vertebrate classes (the fish; the amphibians; the reptiles; the birds and the mammals) and considers both the fundamental similarities between vertebrates and their current taxonomic diversity. Cladistical analysis is introduced as a tool to help you to understand the evolution and taxonomy of the vertebrates. Vertebrate Biology has a special emphasis on reproduction and considers the reproductive biology of each of the vertebrate classes in some detail. Other specialist topics in Vertebrate Biology include vertebrate locomotion and vertebrate developmental biology. In taking this module you acquire a detailed knowledge of the biology of vertebrate animals that provides a useful foundation for a variety of possible careers in the Life Sciences. Resources used in the delivery of this module may include the University of Cambridge Botanic Gardens (e.g. for the study of birds) and also the extensive collection of (largely mammalian) skulls and bones currently held by the School of Life Sciences. An important part of the teacher-managed learning for Vertebrate Biology is the inclusion of "help sessions" on the development of essay-writing skills for undergraduate Life Sciences students at level 5, including instruction on appropriate selection, reading and referencing (Harvard system) of material from the primary scientific literature.

Year 3: Biological Research Skills

This compulsory year two module prepares students for being able to conduct independent research and is particularly relevant to preparing students to undertake their third year research project. Knowledge and skills needed to ask and answer biological questions in a scientifically valid, ethical and safe way will be introduced through lectures and consolidated through hands-on workshops. The quantitative, communication, critical thinking and IT skills gained from this module are applicable to a wide range of graduate employment opportunities.

Year 3: Field Skills in Biology

This module is centred on a field course that will allow you to develop skills in various components of field biology. It will introduce you to the research techniques necessary for conducting fieldwork in temperate habitats, starting with the use of taxonomic keys for the identification of UK fauna and flora, a key skill necessary for those seeking future employment with conservation programmes and ecological consultancies. You will choose four exercises to complete during the first part of the field course, where you will receive training in field techniques in marine, terrestrial or behavioural ecology. These short-term group exercises will be your introduction to conducting comprehensive field research projects from start to finish. As a group, you will choose to present the results from one of these exercises during the field course. Presentations are a major part of scientific conferences where research findings are formally discussed, thus this process will introduce you to the important skills of field project implementation, analysis and presentation. Thorough project design is vitally important in ensuring the successful completion of field-based investigations. This module will thus teach you, through the planning and implementation of separate group projects, how to develop a specific research question through discourse with an academic supervisor and review of relevant literature. You will then develop appropriate methods of data collection and analyses, culminating in the production of an individual research project report. The module will be delivered though lectures, practical sessions and a week-long residential field trip.

Year 3: Principles of Genetics and Evolution

Genetics unifies the biological sciences. Whether you are interested in Animal Behaviour, Biodiversity, Conservation or Zoology, genetics is pivotal, offering a biologically-based explanation for morphological, physiological, and even behavioural traits in an organism. It also gives us a mechanism for the generation and maintenance of variation and the raw material for evolution. Through an integration of concepts at the population, organismal, cellular and DNA levels this module aims to develop an understanding of the core principles of genetics and their applications. The overall goal is to develop a detailed understanding of the relationship between genetic variation and evolution. Firstly we will establish a structural framework on which various ideas and properties of genetic processes can be constructed, through studying the structure and nature of genes and genomes. Next we will consider the rules of inheritance from an individual basis and how do they translate into the organisation of the gene-pool of a population and species. Through this module you will also be introduced to some of the genetic techniques used to answer behavioural, ecological and evolutionary questions. Your understanding of genetic processes will be developed through a variety of problems, case studies and laboratory sessions. As well as providing students with subject specific knowledge, this module helps develop a number of transferable skills including practical (laboratory) techniques and skills relevant to general employment including report writing, data collection, handling and presentation.

Year 3: Personal and Professional Development – Level 5

At Anglia Ruskin University we strive to ensure that students receive an outstanding academic education and student experience and understand that, whilst embedding employability skills within the credit-bearing curriculum is important, it is only part of the set of achievements needed in order to obtain career employment.

This 0-credit module will be used to track and verify the progress students have made with respect to key employability skills and endeavour. Students will work closely with their personal tutor, SU Volunteering Service, Study Skills Plus, and the Faculty Employability Advisor to engage with co-curricular and extracurricular opportunities and activities to enhance their personal attributes.

Year 4: Undergraduate Project

As a Life Science student you are expected to undertake a final year research project focused on a topic relevant to their degree field. Your project may be based on current Anglia Ruskin University research interests, something of interest to you or, if suitable work-place supervision is available, your previous or current employer. Your project must show evidence of appropriate academic challenge, technical expertise, and progress. You will be required to identify and formulate problems and issues,

conduct a literature review, evaluate information, investigate and adopt suitable research methods, develop suitable hardware, software and other media appropriate for data collection and processing. You will demonstrate that you have fulfilled these criteria via regular meetings with your project supervisor where you will show evidence of project development via discussion and the presentation of spoken, written and other appropriate evidence. A substantial dissertation will form the bulk of the assessment for 'Project'.

Year 4: Behavioural Ecology

Behavioural Ecology has been an established discipline within the natural sciences since at least the late 1970s. It brings together the theoretical understanding of evolution and ecology with the observational practices of early ethologists. The underlying premise is that the survival value of behaviour depends on environmental circumstances, both physical and biological. In this module this premise is explored across four major themes: (1) Communication; (2) Finding resources and avoiding being eaten; (2) Living with others of the same species; (3) Producing the next generation. Behavioural Ecology addresses questions at an ultimate level. However, you are shown that an understanding of proximate mechanisms allows a fuller assessment of behavioural alternatives. For example, the causes of, and constraints imposed by, the physiological and anatomical differences between males and females are a core consideration in relation to social systems, mating patterns and allocation of parental care. In other words, why do animals have sex? Why are there sexes? And what are the implications of this on, for example, who they have sex with? The analytical approaches of behavioural ecologists are illustrated throughout using examples. The use of cost-benefit analysis to predict optimal strategies is presented as a key feature used within both economic and game theory models to evaluate behavioural alternatives. For example, game theory can be used to examine the evolution of aggression or cooperation. This module provides a knowledge and skill base relevant to careers in behavioural or ecological biology. In addition, the quantitative and critical evaluation skills developed are applicable to a wide range of graduate employment opportunities. You will develop your understanding of this material through lectures, workshops, research seminars, practical exercises and reading textbooks and journal articles.

Year 4: Wildlife Conservation

Wildlife Conservation is an advanced module in conservation - a critical evaluation of the science underlying conservation biology and an exploration of the multi-dimensional issues faced by working wildlife biologists. The module includes an examination of current conservation problems including socio-political dimensions, and an exploration of the ways in which conservationists set out to find solutions. The module works on the premise that protecting biodiversity is about protecting functioning ecosystems, habitats, species and the genetic diversity hidden within species. Conservation genetics is an increasingly important discipline - the application of new genetic technology in the interest of protecting threatened species, and in captive breeding endangered species with the goal of reintroduction. Identifying priorities for the conservation of global biodiversity and of assessing success and failure of conservation initiatives are examined. An important part of the module is exploring how to make conservation initiatives more effective by accepting the fundamental principle that human interests must be included in conservation planning. The complexity and many faceted nature of wildlife conservation will be explored using examples, and a substantial part of the scheduled sessions will include informal discussion, as well as a formal televised debate. Coursework also includes practical exercises in planning conservation projects, and application for funding. The skills introduced will be applicable to careers in conservation and wildlife management.

Optional Modules

(Subject to availability)

Year 3: Biological Oceanography

This is a marine biology module, founded on level 4 ‘Introduction to Marine Biology’ but with a more prescribed focus. That focus will be the biology, ecology and exploitation of the less familiar open ocean, or pelagic, and deep sea realms. The module has three key themes. First, the biodiversity of ocean plankton, their squid, fish, bird (penguin and albatross) and mammalian (seal and whale) predators, but with the novel introduction of microbes which interact with all of these organisms. Second, concepts of systematics (and identification), biological interactions (between microbes, plants and animals via food-webs and decomposition), human exploitation, over-exploitation and conservation. Third, practical hands on experience of handling, sorting, identifying and recording organisms in plankton samples; culturing and recording marine microbes; and the computer analysis of oceanographic, plankton distribution and fisheries data.

Year 3: Evolution of Behaviour

This module provides you with a detailed overview of the study of animal behaviour. The application of hypothesis testing to questions about behaviour is reviewed and used as a basis for illustrating recent advances in the scientific understanding of animal behaviour. The genetic basis of behaviour is reviewed by examination of innate and acquired behaviours. How behaviour develops in individuals and is modified over time is considered as a process of conditioning and learning interacting with genetic, social and environmental constraints. The organisation of behaviour is reviewed and related to topics such as migration and biological rhythms. The diversity of solutions to the ultimate problems of survival and reproduction are presented within the context of adaptations and proximate solutions to local conditions constrained by the history of evolutionary pathways (physiological, morphological and behavioural). The knowledge and transferable skills provided in this module may help you in gaining relevant employment.

Year 3: Biological Bases of Behaviour

In this module you will examine the 'machinery of behaviour', that is the anatomy, physiology and biochemistry of the nervous system and relevant components of the endocrine system. The course also investigates mechanisms associated with motivation and emotion and how these are thought to be mediated by the brain and endocrine systems. An important topic for any student of behaviour is the relationship between thinking, consciousness, learning and memory and how these relate to the physical 'machinery' of the brain. The localised behavioural functions of the brain are reviewed using the 'split brain' (the difference between the right and left hemisphere) as an explanatory model. The evolution of the nervous system and brain will be discussed including a brief comparative study of equivalent structures across the animal taxa, the implications of such differences in behavioural adaptations is considered. Brain anatomy study workshops allow you to explore the wealth of diversity of brain size and specialisation. This starts with a detailed examination of the mammalian brain in the laboratory. You are directed and guided to prepare a comparative portfolio of the diversity of animal brains across the various animal phyla. Environmental cues are detected by the sensory system, a complex array of sensing receptors located at multiple sites. These will be examined alongside the brain's role in interpretation/perception of sensory signals. This is followed by a study of the role of the basal ganglia and the cerebellum in finely tuned motor control and balance. The external and internal incoming signals promote the action of certain hormones and these will be studied in relation to behaviour, including hormones related to stress, reproduction, and circadian activities (biological rhythms). The module will provide you with a range of practical skills which will be attractive to employers.

Year 3: Animal Health and Nutrition

This module will introduce you to the study of animal health and nutrition with particular emphasis on the relationship between health, disease, nutrition and welfare in domesticated animals. Nutrition is a vital component of animal husbandry and has a major role in maintaining optimal fitness and health. You will examine the essential components of food and learn how they contribute to a balanced diet in domesticated animals. Comparative digestive anatomy and physiology will be discussed to underpin the examination of digestive disorders. The impact of appropriate and inappropriate nutrition on animal health and welfare will be studied. The agents of significant animal diseases including epizootics and zoonoses will be examined as will transmission, management and prevention of disease. The use of veterinary intervention, drugs and feed supplements will be discussed and the impact of these measures on welfare will be considered as will the ethical implications of their deployment in problems of animal disease. The activities of veterinarians and the role of other animal health practitioners will be evaluated. The delivery, assessment and pass marks for this module have been approved by the Royal College of Veterinary Surgeons to enable graduates to apply to enter the register of veterinary nurses.

Year 3: Parasitology

Parasitism, a non-mutualistic symbiosis, is the most prevalent lifestyle among organisms. It is estimated that every plant and animal possesses at least one parasite. Parasites are not only important from a human health perspective, they are also increasingly recognised as playing a significant role in the structuring of ecological communities. Therefore, within this module we aim to provide a thorough introduction the taxonomic diversity and fascinating ecology and evolution of parasites and their hosts. We use the modern classification of parasites which now includes both macroparasites, such as protozoa and helminths, and microparasites, such as viruses and bacteria. Throughout the module the unique relationship between a parasite and its host will be explored from a number of perspectives. Initially we address fundamental questions such as, what is a parasite and what adaptations do parasites possess? We then go on to explore the parasite-host relationship in detail, appreciating that the unique symbiosis between parasites and hosts necessitates an understanding of many disciplines including taxonomy, ecology,

pathology, physiology and immunology. We review the diversity of aquatic and terrestrial parasites and their sometimes complex life cycles within the context of current theories in co-evolution. Finally, we explore parasite mediated behavioural changes with respect to the fitness of vertebrate and invertebrate hosts and their parasites. A series of lectures is supported through laboratory and active learning sessions to ensure that you encounter a wide range of parasite-host associations.

Year 3: Marine and Terrestrial Communities

In this module you will explore the relationships between the linked themes of community ecology and ecosystem functioning in aquatic and terrestrial environments. Community ecology describes patterns and processes within the biological components of an ecosystem. Ecosystem functioning relates to processes of energy flow and nutrient cycling. Fundamental mechanisms that regulate the distribution, abundance and diversity of organisms in communities are examined in a threefold approach combining an understanding of classic ecological theories with practical laboratory and field investigations. Field trips enable participation in long term studies recording dynamic fluctuations in habitat structure. The study of an ecosystem emphasises its dynamic nature by quantifying the fluxes of bioelements (nutrients) and energy through the system. This involves looking at the way that energy and materials are utilised by primary producers and, in turn, by consumers and decomposers. Comparisons in ecosystem productivity are considered together with constraints on cycling of nutrients in aquatic and terrestrial ecosystems. An understanding of how ecological systems operate is important for supporting related behavioural and conservation studies and where an understanding of organisation, patterns and inter-relationships between biotic and abiotic factors in specific habitats is required.

Year 3: Mammalogy

Although relatively few in number, the 6,400 or so known species of extant mammal are of considerable economic and cultural importance. As a vertebrate Class, the mammals are important to us as a food source (most domesticated animals are mammals), as companion animals, in medical and other scientific research, for transport, and as pests and vectors of disease.

This module is about the biology of the mammals and considers mammalian taxonomy, morphology, physiology, ecology, distribution, evolution, and behaviour. A key theme of mammalogy is the analysis of underlying similarities and differences between mammalian taxa, based on an understanding of mammalian evolution and adaptive radiation. Comparisons are

drawn between taxa adapted for a terrestrial, aquatic, fossorial or arboreal mode of living. Practical skills students are expected to acquire during this module include the ability to identify all extant Orders of mammals worldwide, on the basis of distribution and morphology, and, in particular, the anatomy of skulls and teeth.

A key resource for this module is the collection of skulls and other bones held in our labs. Students will develop their understanding of mammalogy through team-based learning, supported through on-line videos, active learning sessions and laboratory-based practical classes. Videos are used to supplement formal teaching, particularly for demonstrating mammalian behaviour and for assisting in species identification. The BBC video series, ‘Life of Mammals’, forms an important component of the reference material for this module.

Year 4: Biogeography

Biogeography describes the spatial distribution of living things and how these have been affected by global change. This 'synthetic' science contains elements of climatology, geology, geography and computer applications but is firmly rooted in biology, particularly ecology, systematics and evolutionary biology. Module delivery is centred around five core themes. (1) Global change: how the Earth has changed in terms of moving continents and oceans, the rise and fall of sea-levels, climate change and recent human impact. (2) Theoretical concepts: from the description of large-scale distribution patterns in the natural world by Darwin and other 19th Century naturalists, explanations of these patterns by the 20th Century ecologists, to post-1980 computer modelling of distribution patterns. (3) Case studies will focus on horses, ratites (ostrich and related big flightless birds), the Indo-Pacific marine fauna, modern mammals, the British flora and the classic work on the origin of the fauna and flora of isolated oceanic islands. (4) Computer application: become conversant with cluster analysis, principal components analysis, cladistics, track analysis and area cladograms using software available via ‘Canvas’, the Virtual Desktop and the Internet. (5) Do-it-yourself: after choosing a group 'of interest' you will need to collect suitable illustrations, so you can develop your evolutionary hypothesis, and distribution maps, to develop your biogeographic hypothesis. The trick is to get the two hypotheses to agree with each other so you end up with an evolutionary story that is plausible in terms of global change. You may literally break new ground and discuss the biogeography of animals and plants groups that have never been scrutinised before. You may also find the computer applications so useful that you incorporate them into your final year dissertation and add them to their c.v.

as evidence of advanced computer skill.

Year 4: Tropical Ecology and Management

This module has at its core a field course in tropical ecology, biodiversity and conservation. It is designed to introduce you to the complex habitats and ecosystems within the tropics. The module also includes a series of lecture-based learning sessions. Field course activities are a mix of group field work on a specific aspects of tropical ecology and visits to one or more locations to observe, record and interpret various aspects of tropical fauna, flora and habitats. Through your experience of the country where the field course takes place and the lectures, you are also made aware of a range of anthropogenic influences and pressures on tropical habitats (e.g. effects of population growth, tourism, economic development etc) and how these relate to conservation. The field course normally takes place in the time of between level 5 (year 2) and level 6 (year 3) and is self-funded. The field trip is quite challenging physically and in terms of living conditions and health for those not used to travel in tropical countries. The course provides good experience for students who have an interest in studying (e.g. research) or working in the tropics.

Year 4: Advanced Approaches in Animal Management

Historically, animal behaviour has been under-emphasised in strategies designed to (1) protect human and non-human animal health and; (2) conserve and manage populations. This module addresses these issues by exploring the interfaces between animal behaviour, disease processes and management strategies. Students will explore the integration of animal behaviour with established and emerging approaches to identifying, monitoring and controlling non-human animal-based problems. The module will teach students to: understand the usefulness and pitfalls of ‘grey literature’; interpret relevant legalisation; and balance the needs of an ever-expanding human population with those of wild and captive animals. Examples of disease issues covered may include current and historical disease epidemics and inter-species transmission of disease (e.g. bovine tuberculosis). Examples of management issues covered may include the importance of understanding and maintaining genetic, behavioural and physiological integrity in captive animals (e.g. zoos/public aquariums, companion animals and farm animals) and minimising the spread and impact of alien species. The major challenges to the successful implementation of solutions based on an understanding of the interfaces between behaviour, disease processes and management strategies are reviewed, including: (1) divergent agendas of governments and NGOs; (2) priorities for human health and welfare; and (3) the need to cope with dynamic systems and goals. Students will also gain an appreciation of how recognising the scale at which issues are tackled (from individual to populations) impacts on approaches, execution of strategies and outcomes. The module will be delivered through a variety of learning strategies such as lectures, workshops, data exercises and debates.

Year 4: Zoos and Zoo Animal Management

Zoos and Zoo Animal Management addresses the question "What are zoos for?" and considers the current and historical role of zoos under the broad headings of recreation, education, conservation and research. It has at its core a field course to major European zoos, designed to introduce you to zoos, the animals they keep, how they are exhibited, and the reasons for keeping them. Upon return to the UK, the module is taught through a series of team-based learning sessions. Through these sessions and your experience of the zoos on the field course, you will consider the history and philosophy of wild animal collections and the various roles played by zoos in modern society. Zoos today face both biological (e.g. captive breeding) and non-biological (e.g. finance and public relations) problems relating to the management of collections of wild animals in captivity. You will consider these problems from several perspectives, ranging from the animals’ welfare to the perceptions of the general public when visiting zoos. Upon completion of the module, you should have an understanding of the complexity of the political, ethical and legal aspects of keeping wild animals in captivity.

Taking Zoo and Zoo Animal Management you will have the opportunity to interact with zoo professionals, work in teams, and present ideas to a specialist audience. Such opportunities and skills strengthen the employability skills of graduates who might want to work in a zoo or other conservation-based environment.

The compulsory field course normally takes place in the summer vacation period between level 5 and level 6 and is self-funded.

Year 4: Coastal Marine Biology

Coastal areas are located at the interface between terrestrial and marine environments. These areas are key to numerous

biological and ecological processes and are hotspots of primary productivity. In a lot of coastal regions, human population densities are very high, creating important potential stresses on both terrestrial and marine environments. Finally these areas are economically crucial for many sectors (such as fisheries and tourism) potentially increasing pressure and requiring mitigation measures.

This module covers the various coastal environments, their structure, dynamics, communities and biological processes. It includes different techniques allowing students to experiment and record data in coastal regions. The potential impacts of natural factors (tides, weather related phenomena) and human activities (resource exploitation, energy generation, and climate change) are explored at both theoretical and practical levels. Mitigation procedures are discussed.

The module is delivered via a mixture of lectures and computer sessions.

Year 4: GIS and Spatial Ecology

This module will provide the students with valuable practical skills in the use of Geographical Information Systems (GIS) in biological sciences. It will include the understanding of the concepts and the training on how to use the techniques during practical sessions (two thirds of the face-to-face teaching time). The students will learn, using relevant case studies, how to use a range of popular GIS software, both commercial (ArcGIS) and Open Source (QGIS).

The students will also learn how to use a GPS to capture locations in the field and how to map them. They will also learn about the latest developments in tracking device technology and how to represent and analyse data acquired from these devices.

During the practical sessions, the students will explore a variety of online spatial data resources relevant to the study of terrestrial and marine organisms in the context of ecological and behavioural studies and wildlife conservation, at both local and global scales. These include species distribution, protected areas, habitat maps, physical and climate data, remote sensing, etc. All these spatial datasets will be imported and processed into a GIS and an array of GIS techniques will be practised to represent and analyse these data in the context of spatial ecology (habitat association, pattern recognition, cost distances…) in order to create high quality cartographic and non-cartographic outputs including statistical analysis outputs.

This module provides a strong link to employment since the knowledge of GIS and the use of these techniques are valuable practical skills. The assessment of this module combines continuous assessment, an intermediate practice map and a final report including the analysis and the representation of spatial data. The assessments mainly focus on the appropriate use of the GIS tools and methods and the quality of the cartographic output.

Year 4: Practical Marine Biology

This module is compulsory for the combined honours Marine Biology course and complements the theoretical 'Coastal Marine Biology' module. Practical Marine Biology comprises a series of lectures and practical workshops delivered at Anglia Ruskin Cambridge as a precursor for a residential field course at a UK marine biology field station. The field course will provide you with advanced skills relevant to marine science including species identification, interpreting oceanographic data and experimental design. The field-work will focus on four aspects of British coastal marine biology: (1) Surveying and collecting samples from varied (rocky/ boulder/ sandy/ muddy) shore environments to explain the distribution of fauna and flora in terms of ecological gradients including tidal immersion/ emersion, exposure to wave action, sediment particle size and biological (grazing/predation/ competition) pressures. (2) Collecting samples from offshore environments, by a research vessel. This ad-hoc sampling could include plankton, mid-water and/or benthic trawls, grab samples and electronic (GPS/ sonar/ sounding/ photographic/ other) data. (3) Detailed systematic diagnosis of any shoreline and offshore collected material. (4) A behavioural analysis of animals in the field and/ or within holding facilities available within the field station, within the confines of appropriate ethical constraints.

Year 4: Countryside Management

Learn the skills and knowledge needed for working in practical ecology or conservation in the UK countryside, or to continuing studying at a higher level in this area. You'll cover aspects of woodlands and forestry in the countryside, agriculture in the countryside, urbanisation of the countryside, management of rivers and wetlands, legislation relevant to managing the countryside, habitat restoration, national parks and upland management. You will also participate in practical exercises, learning survey methods, including the Phase 1 habitat surveys used as industry standard in the UK, and Environmental Impact Assessments (EIAs) with an emphasis on ecological aspects, giving you opportunity to practice writing technical reports. You will

also have the chance to hear from external speakers and participate in a number of field visits.

Year 4: Applied Animal Behaviour and Animal Welfare

This module addresses applied aspects of the science of animal behaviour and shows how behavioural theory and research can be applied to a wide range of practical problems, from pest control to captive breeding and the management of wild populations. A key aspect of the module is the application of behavioural research to vertebrate and invertebrate husbandry. The course also considers the history, philosophy and development of the relatively recent science of animal welfare, including the variety of ethical approaches to the use of animals by humans for varying purposes. The controversial issue of how to assess animal welfare through behavioural and physiological indicators is addressed, and specialist techniques which may support such assessments are introduced. While undertaking this module you will study and critically evaluate the captive management of animals and how this may support or impinge on their welfare, covering farm, companion, laboratory, sport and zoo animals. Current legislation and regulations governing captive breeding and animal welfare are reviewed and evaluated. This module will prepare you for careers in animal-related or ancillary industries, including postgraduate scientific research. It will develop your understanding of the application of the scientific study of animal behaviour and its relationship with other measures (particularly with respect to the evaluation of welfare) in a range of animal management scenarios. You will have access to suitably equipped laboratories and animal resources where relevant.

Year 4: Population Ecology and Wildlife Management

This module will focus on the first principles of population ecology, and the ways this body of theory is applied practically in wildlife management. An important focus is the demography and dynamics of natural populations - both plant and animal populations. In the early part of the module you will be guided sympathetically in the basic mathematical tools (basic operations of linear algebra) used in population ecology with the goal of understanding the scientific literature in population ecology and wildlife management. Population ecology will be put into the wider context of current developments in population genetics, evolutionary biology and animal behaviour. Life history strategies will be explored, the attributes of r- and K-selected species and the associated problems of management and conservation. The consequences of species interactions - predator-prey, competitive interactions, and the effect of parasites - will form an important part of the module. You will have the opportunity to collect and analyse original data, and contextualise these results within current research in the discipline - skills which will contribute to employability of graduates in the field of wildlife biology and management. Through the study of examples students will review and assess the factors which are important in the population dynamics, management and conservation of wild populations. The current scientific literature is a critical resource; you will read scientific papers relating to marine and terrestrial ecosystems, and both exploited populations (e.g. fisheries) and threatened populations that are conservation priorities. An important theme throughout the module is the changing understanding of the efficacy of implementing theory in the real world and students will be required to critically evaluate the effectiveness of management practices.

Year 4: Animal Communication

This module examines the processes by which animals communicate, i.e. provide information to other individuals and how they can incorporate this information into their decision making. We will discuss different communicative modalities, such as olfactory, tactile, visual, and acoustic signals. We will address fundamental questions in animal communications, for example how do these signals evolve, how are they produced and which functions do they serve? The module will cover the physical and biological bases of signal production and perception. We will discuss animal communication as a rapidly growing field of research in various disciplines including animal behaviour, behavioural ecology, neurobiology and animal cognition and how an understanding of animal communication can inform many aspects of animal behaviour, such as emotional expression, learning and sexual behaviour. We will explore cognitive underpinnings of animal communication. You are exposed to tools and skills that will allow you to conduct research in this area yourself - through lectures, practical demonstrations and exercises. We will consider similarities and differences between animal and human communications and evaluate theories of language evolution.