

Part IB Evolution and Animal Diversity

2019-20



*Cover image: 'Final approach' — James's flamingos (Phoenicoparrus jamesi),
Los Flamencos National Reserve, San Pedro de Atacama, Chile*

NST Part IB Evolution and Animal Diversity

Welcome to IB Evolution and Animal Diversity

(formerly IB Animal Biology)

This course is about the principles of evolution and how they underlie the extraordinary diversity of animals. It will give you an overview of how the form, function and behaviour of animals are adapted to different lifestyles and environments via evolution through time. The course comprises four sections: Behavioural Evolution, Genes and Genomes, Macroevolution and Diversity, and Adaptations. You will be taught by lecturers who are actively researching in these fields, and the breadth of topics, questions and approaches of IB Evolution and Animal Diversity will allow you to choose a broad range of subjects for your third-year studies.

Each six-lecture block will be accompanied by a practical related to the lectured material and designed to develop your scientific skills. Your write-ups of the practicals will be assessed and will contribute to your final mark.

After completing the course you should be familiar with the breadth of evolutionary biology and animal diversity, including physiological adaptations, behavioural adaptations, evolutionary genomics and macroevolution. The course will equip you to pursue topics related to whole organisms, evolutionary genetics and ecology in Part II modules.

Whilst it may be an advantage to have taken Part IA Evolution and Behaviour, it is not essential, nor is any other particular first year course. Interested students who have no experience of biological courses in Part IA are advised to consult their Director of Studies. Part IB Evolution and Animal Diversity relates well to other IB courses such as Ecology, Evolution and Conservation, Experimental Psychology, Geological Sciences A, Physiology, Cell and Developmental Biology, Plant and Microbial Sciences or Neurobiology; however, it is not necessary to take any particular accompanying courses.

Lectures:

Monday, Wednesday and Friday

11am-12pm, Main Lecture Theatre, Department of Zoology.

MICHAELMAS TERM

Behavioural Evolution

Evolution of survival & reproductive strategies	Professor Nick Davies
Development of adaptive behaviour	Professor Becky Kilner
Phenotypic models	Professor Rufus Johnstone

Genes and Genomes

Population and quantitative genetics	Dr Nick Mundy
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LENT TERM

Genes and Genomes

Population genomics and infectious disease	Professor Frank Jiggins
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Macroevolution and Diversity

Phylogeny and macroevolution	Professor Chris Jiggins
Vertebrate origins and evolution	Dr Jason Head
Vertebrate diversity	Dr Robert Asher

EASTER TERM

Adaptations

Insect physiology and evolution	Dr Walter Federle
Nervous systems	Dr Marta Zlatic

Practicals:

Every other Wednesday 12-5pm or Thursday 12-5pm, Elementary Laboratory, Department of Zoology. Practicals are assessed and in total count for 20% of the final grade.

Further information on the course including a synopsis of lectures and practicals is available on the IB Evolution and Animal Diversity website via:

<https://www.biology.cam.ac.uk/undergrads/nst/courses>

For any questions please contact the course organiser: Dr Nick Mundy (nim21@cam.ac.uk), Department of Zoology.

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BEHAVIOURAL EVOLUTION



How does behaviour enable individuals to adapt to an ever-changing physical and biological environment? We show how predictions can be derived from evolutionary theory and tested by comparative studies and experiments. Ecological factors provide the stage on which behaviour is played and natural selection favours those behavioural and developmental strategies which maximise an individual's chances of survival and reproduction.



- How do fitness trade-offs influence: reproductive strategies and parental care; group-living and competition for scarce resources?
- How does adaptive behaviour develop and what determines the relative contribution of genes, learning and the wider environment?

References

Davies, N.B., Krebs, J.R. & West, S.A. (2012).

An Introduction to Behavioural Ecology. 4th edition. Wiley-Blackwell.

Manning, A. & Dawkins, M. S. (2012)

An Introduction to Animal Behaviour, 6th Edition. Cambridge University Press.



Prof. Nick Davies



Prof. Rebecca Kilner



Prof. Rufus Johnstone

GENES AND GENOMES



Evolution of populations depends on their underlying genetics. Although the main principles of population genetics have long been established, advances in genomics over the past decade have resulted in a spectacular increase in our understanding of the genetic variation found in natural populations.

These lectures will examine the genetic changes to populations and genomes that occur during evolution, and how genetic data can be used to reconstruct the evolutionary forces acting on populations and species. These principles will be further illustrated with lectures on the evolution of hosts, pathogens and infectious disease.

We will explore:

- The genetic processes and principles that underlie evolutionary change.
- Using genetic data to make inferences about evolutionary processes.



References

Zimmer, C. & Emlen, D. J. (2013),

Evolution. Making sense of life, Roberts & Co.

Nicholas H. Barton, Derek E. G. Briggs, Jonathan A. Eisen, David B. Goldstein, Nipam

H. Patel (2007) *Evolution*. Cold Spring Harbor Press. Chapters 15 and 16.



Dr Nick Mundy



Prof. Frank Jiggins

MACROEVOLUTION AND DIVERSITY

This section will focus on three areas:

- Phylogeny and macroevolution.
- Vertebrate origins, systematics, and development.
- Amniote evolution and diversity.



Lectures will cover the construction of phylogenies and their use in comparative analysis, and ancestral state reconstruction. We will also discuss the importance of considering incomplete lineage sorting and hybridisation in phylogeny reconstruction, and how phylogenies can be used to study patterns of diversification and the drivers of speciation.



Lectures will explore the evolution of embryological growth, skeletal tissues, respiratory and circulatory systems, metabolism, sensory systems in vertebrates.

Vertebrates are among the most complex and morphologically diverse animals. We will examine developmental, fossil, and modern anatomical data in order to understand the evolution of tissue systems during major transitions in vertebrate history. These events include the evolution of paired appendages and jaws, the emergence onto land from water, and the origins of endothermy.



References

Baum, D. A. & Smith, S. D. *Tree Thinking: An Introduction to Phylogenetic Biology*. (Roberts, 2012).

Kardong, K.V. (2009). *Vertebrates. Comparative Anatomy, Function, Evolution* (5th Edition). McGraw Hill.

Bonnar, M. F. (2016). *The Bare Bones: An unconventional evolutionary history of the skeleton*. Indiana University Press.



Prof. Chris Jiggins



Dr Jason Head



Dr Robert Asher

ADAPTATIONS

Insects are the most diverse and successful group of animals on Earth. We will seek to explain the insects' success by studying their adaptations to an enormous diversity of life styles, looking at their physiology, ecology and evolution.



In order to understand the neural control of complex and adaptive behaviour we need to clarify the ways in which animal brains function, how they operate in the detection and processing of sensory information and how sensory and motor functions are finally integrated at the level of neurons and networks to generate behaviour.

The lectures and practical classes will explore:

- Insect cuticle, respiration, water balance, locomotion, feeding and insect-plant relationships.
- The cellular basis of neural processing, olfactory, visual, auditory and somatosensory pathways in insects, and decision making and memory circuits.

References

Eisner T. (2003) *For Love of Insects*. The Belknap Press of Harvard University Press, Cambridge, MA.

Gullan, P.J. & Cranston, P.S. (2014) *The Insects. An Outline of Entomology*, 5th edition. WILEY Blackwell.



Dr Walter Federle



Dr Marta Zlatic



© Jamie Gundry Wildlife Photography

Suggested background reading

Carroll, S.B. (2007) *Endless Forms Most Beautiful: The new science of evo devo and the making of the animal kingdom*. Phoenix: paperback.

Coyne, J. (2009) *Why Evolution is True*. Oxford University Press.

Davies, N. (2016) *Cuckoo: Cheating by Nature*. Bloomsbury (paperback).

Shubin, N. (2008) *Your Inner Fish*. London: Penguin.

Wilkinson, M. (2016) *Restless Creatures: The story of life in ten movements*. Icon books (paperback).

*Back image: 'Feeding in the surf' — Sally Lightfoot crab (Grapsus grapsus),
Santa Cruz, Galápagos Islands, Ecuador*

