**Summer Studentships 2021 Projects List**

**Host Unit:** Alic lab, Institute of Healthy Ageing  
**Supervisor:** Dr Nazif Alic  
**Project Title:** The ability of long-lived mutants to maintain metabolic homeostasis in old age

**Project outline**  
Alterations to metabolic homeostasis, which can result in obesity and insulin-resistance (type II diabetes) are an ever-growing concern to our society, and are at least in part due to the caloric excess of our modern diet. Both obesity and insulin-resistance have a complex interaction with a person’s age. Recent exciting work in biogerontology has discovered interventions that can extend lifespan in organisms as diverse as the fruit fly and mammals. However, it remains unclear whether longevity extending manipulations can lead to better metabolic homeostasis and counteract poor diet choices, preventing obesity and insulin-resistance. This project will examine if mutations that can make the fruit fly live longer can also rescue from the effects of poor diet, using a range of techniques in fly physiology and molecular and cell biology.

**Deadline for contact:**  
10 January 2021. Applicants should send a cover letter, brief CV & contact details of a referee.

**Contact:** n.alic@ucl.ac.uk
Host unit: Gems lab, Institute of Healthy Ageing

Supervisor: Prof. David Gems

Project Title: Biology of Ageing in C. elegans

Project outline
The project will involve some aspect of the biology of ageing in *C. elegans*, to be determined closer to the date of the project.

While developmental genetics has been an area of intensive study for many years, investigation of the role of genes in determining longevity and ageing only recently began. An ideal model organism in which to study ageing is the free-living nematode *Caenorhabditis elegans*. This species has well-developed genetics, its 97,000,000 base pair genome is fully sequenced, and its life span is a mere 2-3 weeks. Most importantly, numerous mutations have been identified in *C. elegans* which alter the rate of ageing, with some mutants living more than five times as long as wild-type worms. It is hoped that by understanding ageing in a simple animal like *C. elegans* we will be able to unravel the mystery of human ageing, which increases risk of a wide range of diseases, from cardiovascular disease and type II diabetes, to Alzheimer's disease and cancer.

A major focus of current work in this laboratory is understanding the genes and biochemical processes by which reduced insulin/IGF-1 signalling and dietary restriction increase lifespan. Other interests include sex differences in the biology of ageing, evolutionary conservation of mechanisms of ageing, and bioethical implications of ageing research.

Special requirements
These projects are suited for students who are considering a possible future career in scientific research. A good grounding in genetics is helpful.

Deadline for contact
10 January 2021. Applicants should send a cover letter, brief CV & contact details of a referee.

Contact: david.gems@ucl.ac.uk
Host unit: Aida Andrés lab, UCL Genetics Institute

Supervisor: Dr. Aida Andrés

Project Title: Local adaptation in face morphology and temperature sensation in humans.

Project outline

Even as a relatively recent species with limited population differentiation, humans have been able to adapt to a striking diversity of environments. We are interested in understanding how these adaptations happened and how they have contributed to the (otherwise modest) genetic differentiation among human groups. To do this, we compare the genomes of humans from different populations, to identify loci that show signatures of local adaptation. In this project, we will investigate the signatures of local adaptation in genes involved in face morphology, which differs substantially among human groups, and sensation of temperature, which varies widely across human habitats. The student will use large genomic datasets to investigate the signatures of local adaptation in neutrality tests that have been pre-computed in the group. They will investigate and combine the signatures of selection in each gene, and use literature searches to interpret the results. The ideal student will have a solid background in R and/or programming and a strong interest in population genetics.

Deadline for contact

10 January 2021. Applicants should send a cover letter, brief CV & contact details of a referee.

Contact: a.andres@ucl.ac.uk
**Host unit:** Nick Lane’s research group  
**Supervisor:** Prof. Nick Lane  

**Project 1 title:** How energy flow structures metabolism and heredity at the origin of life.  

**Project 1 description**
How energy flow structures metabolism and heredity at the origin of life. We have several experimental and computational projects that address different aspects of the origin of life from an energetic perspective, specifically how the first cells came to be powered by proton gradients across membranes. The student would be able to choose, depending on their interests and progress in the meantime, between projects on CO2 reduction across inorganic barriers, the behaviour of fatty acid protocells, aspects of nucleotide synthesis, and interactions between amino acids and nucleotides. Computational projects would focus on the origin of the genetic code in relation to the coevolution of metabolism and the code.

**Project 2 title:** How mitonuclear interactions shape mitochondrial function and fitness in *Drosophila*  

**Project 2 description**
This work would be in collaboration with Dr Flo Camus and uses a well-established fruit fly model to study mitonuclear incompatibilities. Several different projects would be available depending on the interest of the student and progress in the meantime, ranging from fluorespirometry using the Oroboros O2K to measure mitochondrial function, to analysis of metabolomic and proteomic datasets, to exploration of phenotypes in flies, ranging from male or female fitness to activity and lifespan. Projects could relate to the effects of diet, temperature and drug responses with a focus on overall physiology or brain-specific metabolism linked to dementia.

**Deadline for contact**
10 January 2021. Applicants should send a cover letter, brief CV & contact details of a referee.

**Contact:** nick.lane@ucl.ac.uk
Host unit: Andrew Pomiankowski’s research group

Project 1 Supervisors: Prof Andrew Pomiankowski and Prof Nick Lane

Project 1 Title: The metabolic costs of an exaggerated sexual ornament in stalk-eyed flies

Project 1 description

Male stalk-eyed flies have highly exaggerated eyespan. This is a classic example of sexual selection, caused by strong female mate preferences for males with wider eyespan. We know this trait imposes aerodynamic costs on males (they take-off at a lower angle, due to the extra head weight), it slows development (males take 1-2 extra days to emerge from pupae) and is a highly condition-dependent trait (being very sensitive to environmental and genetic stress). Eyespan is a means for females to assess male phenotypic and genetic quality. The project will break new ground in examining the energetic costs of exaggeration. The student will measure a range of metabolic parameters in males, e.g. oxygen consumption and reactive oxygen species (ROS) flux. By introducing different substrates, the performance of mitochondrial complexes I-IV can be assessed under environmental stress. These features of the energetic state will be compared across males with different eyespan exaggeration. The student will compare different tissues (head, thorax and reproductive organs) in males and females, as well in larvae when eyespan size is determined. We hypothesize that metabolic trade-offs between investment in growth and development versus aerobic capacity for flight and aerodynamics underpin differences in eyespan, with the honesty of the handicap signal primarily reflecting metabolic fitness.

References


Project 2 Supervisors: Prof. Andrew Pomiankowski and Prof. Jon Bridle

Project 2 Title: Selfish genetic elements and sexual selection

Project 2 description

Selfish genetic elements spread because they enhance their own transmission at the expense of organismal fitness. But what is their effect on populations fitness, do they enhance or resist extinction? In this project, we will build on a decade of theoretical and experimental work on X-linked meiotic drive. Drive males sire female-only broods (Y-bearing sperm are dysfunctional) leading to a female biased population sex ratio. This raises population birth rates and is predicted to resist the chances of extinction. But X-linked drivers are typically located in chromosomal inversions which accumulate deleterious mutations. And as drive spreads, males become rare, leading to reduced female mating, with predicted reduced fertility and promotion of extinction. So drive has both positive and negative effects on population fitness. These ideas will be studied in the stalk-eyed fly which carries sex-ratio, an X-linked meiotic driver. This species is also a classic examples of sexual selection caused by strong female mate preferences for males with exaggerated eyespan. Population cage experiments will be used to test how the frequency of meiotic drive, the population sex ratio and the opportunity for mate choice contribute to population persistence.

References

Mackintosh, C., Pomiankowski, A. and Scott, M. F. 2020 X-linked meiotic drive boosts population size and persistence. bioRxiv 137224
**Deadline for contact**

10 January 2021. Applicants should send a cover letter, brief CV & contact details of a referee.

**Contact:** Prof. Andrew Pomiankowski ([ucbhpom@ucl.ac.uk](mailto:ucbhpom@ucl.ac.uk))