How does the one-humped Arabian camel survive in the desert without drinking?

Primary supervisor: Prof David Murphy (d.murphy@bristol.ac.uk)
Secondary supervisor: Dr Michael Greenwood (mike.greenwood@bristol.ac.uk)

Whilst water balance is aggressively defended in all mammals, this is all the more so in the one-humped Arabian camel, which has a remarkable capacity to thrive in the hot, arid conditions of the Arabian deserts (1), and to survive extended periods of dehydration (2). Whereas other mammals would die from circulatory failure when water loss reaches 12% of body weight, the camel can tolerate up to 30%. Water economy is key to survival in the desert; thus, at the level of the kidney, the camel produces a low volume of highly concentrated urine, especially following dehydration, as a consequence of the highly efficient reabsorption of water (3). This is mediated by the actions of the antidiuretic hormone arginine vasopressin (AVP), which is made in a specialised part of the brain called the hypothalamo-neurohypophysial system (HNS). AVP interacts with specific receptor targets located in the kidney to promote water reabsorption in the collecting duct (10). Circulating levels of AVP increase following dehydration in the camel (4), and the sensitivity of the renal response to AVP is 100 fold greater in camel compared with cattle (5). The mammalian brain regulates water balance through the synthesis and secretion of the antidiuretic hormone arginine vasopressin (AVP) by the hypothalamo- neurohypophysial system (HNS). AVP is synthesised in HNS neurones which project axons to terminals located in the posterior lobe of the pituitary (PP), where mature AVP is stored until released into the circulation in response to electrical activity evoked by physiological cues. AVP acts on the kidney to provoke water reabsorption. Interestingly, the ultrastructure of the camel HNS changes according to season, suggesting that in the arid conditions of summer, the dromedary HNS is in a state of permanent activation, in preparation for the likely prospect of water deprivation. We have recently sequenced the genome of *Camelus dromedarius.* Based on this unique resource, we will now describe, in comprehensive detail, the transcriptome of the camel HNS, and how this is altered by dehydration. HNS transcriptome datasets will be compared to existing rodent data sets, and subject to bioinformatic analyses to reveal nodal target genes, which will be validated at the RNA and protein levels. Gene function will be tested *in vivo* in established rat models by HNS injection of viral vectors that over-express or knockdown targets.

References

1. Ouajd & Kamel (2009) Physiological perculiarities of Dromedary (Camelus dromedarius) and experimental implications. Scand J Lab Anim Sci 36:19
2. Gaughan (2011) Which physiological adaptation allows camels to tolerate high heat load – and what more can we learn? J Camelid Science 4:85
3. Ben Goumi et al.(1993) Hormonal control of water and sodium in plasma and urine of camels during dehydration and rehydration. Gen Comp Endocrinol 89:378
4. Ali et al. (2012) Responses to dehydration in the one-humped camel and effects of blocking the renin-angiotensin system. PLoS One 7:e37299
5. MacFarlane et al. (1963) Turn-over and distribution of water in desert camels, sheep, cattle and kangeroos. Nature 197:270

Skills: RNAseq transcriptomics, real time PCR, in situ hybridisation, immunocytochemistry, comparative physiology, in vivo gene transfer, physiological analysis, bioinformatics.

Subject areas: Agricultural Sciences, Ecology and Conservation, Endocrinology, Molecular Biology, Neuroscience, Physiology, Zoology