C5.15
Thermal effects on cephalopod energy metabolism — A case study for *Sepia officinalis*

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Cephalopods are the largest, most active invertebrates and there is considerable evidence for their convergent evolution with fishes. However, most active cephalopods display standard and active metabolic rates that are several-fold higher than comparably sized fishes. Shifting habitat temperatures due to climate change will therefore affect a cephalopod's energy metabolism much more than that of a fish. Prediction of the probable outcome of cephalopod fish competition thus requires quantitative information concerning whole animal energetics and corresponding efficiencies. Migrating cephalopods such as squid and cuttlefish grow rapidly to maturity, carry few food reserves and have little overlap of generations. This "live fast, die young" life history strategy means that they require niches capable of sustaining high power requirements and rapid growth.

This presentation aims to draw a bottom-up picture of the cellular basis of energy metabolism of the cuttlefish *Sepia officinalis*, from its molecular basis to whole animal energetics based on laboratory experiments and field data. We assessed the proportionality of standard vs active metabolic rate and the daily energetic requirements using field tracking data in combination with lab based respirometry and video analysis. Effects of environmental temperature on mitochondrial energy coupling were investigated in whole animals using *in vivo* ^{31}PNMR spectroscopy. As efficient energy turnover needs sufficient oxygen supply, also thermal effects on the blood oxygen-binding capacities of the respiratory pigment haemocyanin and the differential expression of its isoforms were investigated. Supported by NERC grant NERC/A/S/2002/00812.

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C5.16
Molecular mechanism which underlie the development of endothermy in birds (*Gallus gallus*)

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The evolution of endothermy is associated with high metabolic rates and internal heat production. During embryogenesis endotherms cannot regulate their body temperature metabolically and are therefore similar to ectotherms. The transition from ectothermy to endothermy occurs by the development of metabolic capacity during embryogenesis. Transcriptional control is an important mechanism that regulates metabolic capacity to establish endothermy. Recently we have shown that PGC-1a known as a metabolic master regulator in mammals, as well as its target PPARγ is upregulated during embryogenesis in birds. Interestingly, upregulation of PGC1a during embryogenesis coincides with upregulation of plasma triiodothyronine levels, and functional maturation of thyroid hormones is an important component in the development of endothermy. Additionally, heat production in endotherms is facilitated by greater mitochondrial membrane proton conductance due to higher rates of basal proton leak across the inner mitochondrial membrane compared to ectotherms. Therefore, the aims of this study were to determine firstly to what extent the increase in metabolic capacity during embryogenesis in a bird (*Gallus gallus*) is associated with an increase in uncoupling of the electron transport chain from oxidative phosphorylation. We show that suppression of palmitate stimulated uncoupling by blocking ATP/ADP-antiporter is significantly greater after hatching. Secondly, we investigated whether thyroid hormones are important to establish thermogenic capacity via regulating PGC-1a gene expression. Our preliminary results show that following pharmacologically induced hypothyroidism, PGC-1a gene expression is significantly reduced. Our findings elucidate the interaction between different mechanisms that lead to the development of endothermy.

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C5.17
Seasonal acclimatization of body temperature and metabolic capacities in an Australian rat (*Rattus fuscipes assimilis*)

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The energetic cost of maintaining the relatively high and stable body temperatures (T_b) of endotherms increases with decreasing environmental temperatures (T_e). Small mammals that remain active during winter may offset this cost by decreasing T_b, and may also increase metabolic capacities to facilitate internal heat production. The aim of this project was to determine whether seasonal fluctuations in environmental temperature influence body temperature and metabolic regulation in a rat (*Rattus fuscipesassimilis*). In the wild, winter mean T_b (36.66 °C±0.02) was significantly lower than in summer (37.01 °C±0.06), and T_b amplitude (T_{bmax}-T_{bmin}) was significantly greater in winter (3.42±0.10) than summer (3.01±0.12). States 3 and 4 mitochondrial oxygen consumption was significantly higher in winter rats as were cytochrome c-oxidase and lactate dehydrogenaseactivities. The thermal sensitivity of enzyme activities was reduced in winter acclimatized rats. When acclimated to cold (12 °C) and warm (24 °C) conditions in the laboratory, running performance and metabolic scope were significantly increased at low temperatures in the cold acclimated rats compared to the warm acclimated rats. Hence, rather than regulating to a fixed body temperature, mammals can maintain performance and reduce energetic cost in cooler thermal environments by regulating to a lower body temperature and concurrently increasing metabolic heat production capacity and shifting thermal sensitivities of metabolic pathways.

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C5.18
Costs and benefits of cold acclimation in field released *Drosophila* — Associating laboratory and field results

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Physiological and evolutionary responses to thermal variation are often investigated under controlled laboratory conditions. However, this approach may fail to account for the complexity of natural environments. Here we investigated the costs and benefits of developmental or adult cold acclimation using the ability of field released *Drosophila melanogaster* to find a resource as a proxy of