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ENERGY METABOLISM OF PARASITE — THEIR STRATEGY FOR ADAPTATION —

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Parasites exhibit greater diversity in energy metabolism than do the host animals, and many have exploited unique strategy as adaptation to their natural habitats. We have been studying on the respiratory chain of parasitic helminth, *Ascaris suum*. These studies include the identification of unique features of anaerobic respiration in adult parasites, the elucidation of molecular structures of the components involved and an understanding of the developmental changes that occur during their life cycle.

Adult worm of *A. suum*, resides in the host small intestine, where oxygen tensions are low, and has a unique anaerobic mitochondrial respiratory chains. In this anaerobic chain, the reducing equivalents from NADH are transferred to the fumarate reductase (FRD) of complex II (succinate-ubiquinone oxidoreductase : SDH), and this electron transfer is coupled a site 1 phosphorylation by the proton pumping in complex I (NADH-ubiquinone oxidoreductase complex). The NADH-fumarate reductase system is found not only in adult *A. suum*, but in many other anaerobic parasites as well. It should be stressed that unlike mammalian complex II (SDH), complex in adult *A. suum* functions in the reverse direction (FRD). In contrast to findings for the adult namatode, oxygen is required for larval development, and the respiratory chain of the mitochondria isolated from free-living second stage larvae (L2) has substantial cytochrome oxidase activity and is similar to that of the aerobic mammalian host. The SDH/FRD ratio of larval mitochondria decreases at latter stages of development. This change in the SDH/FRD ratio during the life cycle suggests the two isoforms of complex II exist in *A. suum*. From the biochemical analysis, we have found two distinct enzyme complexes, and complex II in larval mitochondria is more similar to aerobic mammalian enzymes with low FRD activity. Among four subunits in the complex II, at least flavoprotein (Fp) subunit and the small subunit of cytochrome *b* (cybS) of larval complex II were different from those of adult complex.

The amino acid sequence of adult *A. suum* Fp deduced from cDNA is very similar to that of the *Caenorhabditis elegans*, which is well known free-living nematode, even though the ascarid enzyme functions as FRD in adult *A. suum*, while the *C. elegans* enzyme functions as SDH. Much less similarity is obserbed between the adult *A. suum* Fp and that of the bacterial FRD, supporting our previous finding that complex II of adult *A. suum* is more closely related to *Escherichia coli* SDH and complex II of

aerobic mitochondria than the bacterial FRD. These result suggest that the complex II of adult *A. suum* evolved from complex II of free-living nematode, such as *C. elegans*, and FRD activity of the complex II of adult *A. suum* probably was acquired during its adaptation to microaerobic habitats during the transition to a parasitic life style. Our recent sequence analysis of cDNA for Fp of larval complex II clearly confirms this idea.

REFERENCES

1) TAKAMIYA, S., KITA., K., WANG, H., WEINSTEIN, P. P., HIRAISHI, A., OYA, H., and AOKI, T. : Developmental changes in the respiratory chain of *Ascaris* mitochondria. *Biochim. Biophys. Acta* **1141** : 65–74, 1993.

2) KURAMOCHI, T., HIRAWAKE, H., KOJIMA, S., TAKAMIYA, S., FURUSHIMA, R., AOKI, T., KOMUNIECKI, R., and KITA, K. : Sequence comparison between the flavoprotein subunit of the fumarate reductase (Complex II) of the anaerobic parasitic nematode, *Ascaris suum* and the succinate dehydrogenase of the aerobic, free-living nematode, *Caenorhabditis elegans*. *Mol. Biochem. Parasitol.* **68** : 177–187, 1994.

3) KURAMOCHI, T., KITA, K., TAKAMIYA, S., KOJIMA, S., and HAYASAKI, M. : Comparative study and cDNA cloning of the flavoprotein subunit of mitochondrial complex II (succinate-ubiquinone oxidoreductase : fumarate reductase) from the dog heartworm, *Dirofilaria immitis*. *Comp. Biochem. Physiol.* **111B** : 491–502, 1995.

4) SARUTA, F., KURAMOCHI, T., NAKAMURA, K., TAKAMIYA, S., YU, Y., AOKI, T., SEKIMIZU, K., KOJIMA, S., and KITA, K. : Stage-specific isoforms of complex II (succinate-ubiquinone oxidoreductase) in mitochondria from the parasitic nematode, *Ascaris suum*. *J. Biol. Chem.* **270** : 928–932, 1995.

5) SARUTA, F., HIRAWAKE, H., TAKAMIYA, S., MA, Y-C., AOKI, T., SEKIMIZU, K., KOJIMA, S., and KITA, K. : Cloning of a cDNA encoding the small subunit of cytochrome b_{558} (cybS) of mitochondrial fumarate reductase (complex II) from adult *Ascaris suum*. *Biochim. Biophys. Acta* **1276** : 1–5, 1996.