Cadmium Transport Research Impacts Environmental Community

Every day, we are exposed to hundreds of chemicals—in the food we eat, the water we drink, and the air we breathe. But what are the pathways by which these materials are transported? And what are the ramifications of this transfer? Dr. William Robinson, a Professor at UMass Boston in the Environmental, Earth, and Ocean Sciences Department, has been researching the mechanistic toxicology of cadmium and other metals for more than a decade. His research primarily focuses on bivalve mollusks (mussels and clams), but it has a much more widespread application than one might expect.

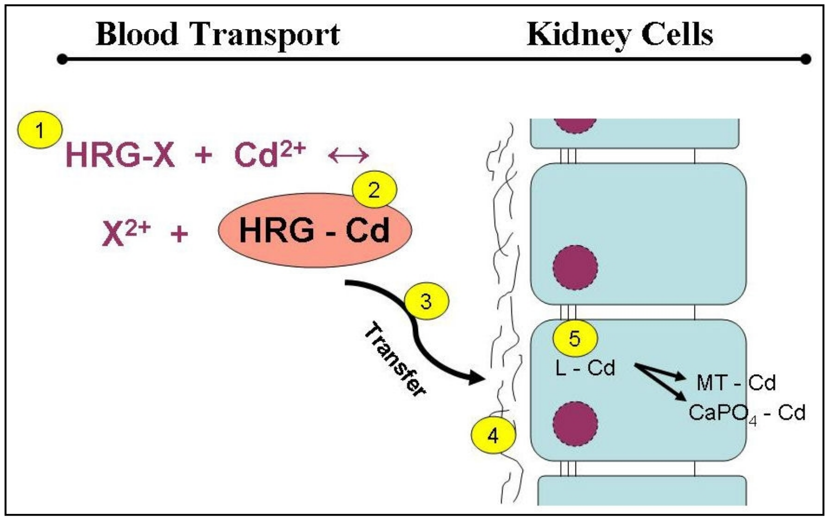

Fig 1. The HRG transport – transfer model in bivalves. HRG starts out either as an apoprotein (with no metal) or as a Ca or Zn protein (1). When in contact with Cd, this metal displaces Ca and Zn (2). Cd is then rapidly transferred to the kidney (3). Glycosaminoglycans in the basal membrane of kidney cells may be involved in the recognition of Cd-laden HRG (4). Once inside the kidney epithelial cells, Cd is redistributed to metallothionein and to calcium phosphate granules (5).

Dr. Robinson is currently investigating the biochemical, molecular, and physiological mechanisms that bivalve mollusks use in response to cadmium exposure. Specifically, his research concentrates on how cadmium is transported via the circulatory system to the kidney (see Figure 1), where it is either excreted or stored, and what damage the organism incurs. While several pathways from the circulatory system to the kidney exist, cadmium is primarily transported via Histidine-rich Glycoprotein (HRG), a single plasma protein. When cadmium binds to HRG, the metal is dropped off in the kidney at a very rapid pace. In all other organs of the organism, this transport does not occur as fast is it does to the kidney. Dr. Robinson and his research team have demonstrated that HRG is present in at least six different species of bivalve mollusks (see Figure 2). This transport route is also similar to what is known to occur in human blood.

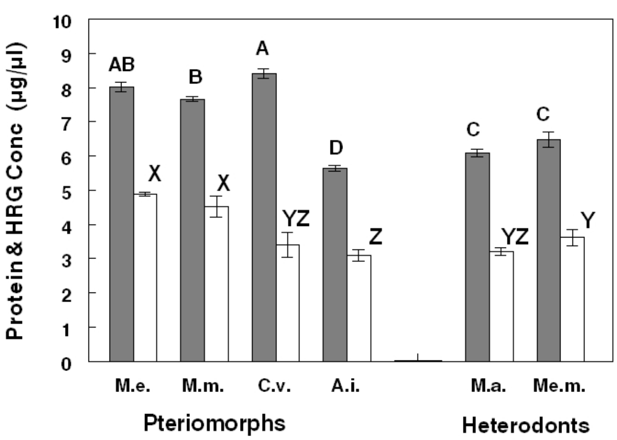

Fig 2. Mean total plasma protein concentrations and HRG concentrations in six bivalve species. Bars designated with the same letters represent means that are not significantly different (P>0.05). M.e.= *Mytilus edulis*; M.m. = *Modiolus modiolus*; C.v. = *Crassostrea virginica*; A.i. *Argopecten irradians*; M.a. = *Mya arenaria*; and Me.m.. = *Mercenaria mercenaria*.

The impacts of Dr. Robinson's research are widespread. Ocean acidification is a pressing issue in the environmental community. The 0.1 pH unit drop since pre-industrial times may seem insignificant, yet it represents a 26% increase in hydrogen ion concentration. An additional drop of 0.3 pH units (a 151% increase in H^+) is expected by 2100. This increase has been demonstrated to interfere with calcium homeostasis in marine bivalves. Fertilization rates and growth rates are both down due to this phenomenon. Currently, SMS student Marianna Nappi is working with Dr. Robinson to study the impacts of elevated CO_2 on binding of cadmium and calcium to HRG, to see if the ocean acidification affects metal homeostasis in commercially important shellfish.