

## **NOVEL PROPERTIES OF INDIVIDUAL MYOSIN HEADS IN SKELETAL MUSCLE AS REVEALED BY EXPERIMENTS USING THE GAS ENVIRONMENTAL CHAMBER**

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Although it is generally believed that muscle contraction results from ATP-driven cyclic attachment and detachment between myosin heads extending from myosin filaments and corresponding myosin-binding sites on actin filaments, the movement of myosin heads remains to be a matter for debate and speculation. The most straightforward way to visualize and record individual myosin head movement coupled with ATP hydrolysis is to use the carbon film-sealed gas environmental chamber (EC), which enables us to keep biological specimens like muscle actin and myosin filaments in wet, living state in the high vacuum of a transmission electron microscope. We have succeeded in recording ATP-induced movement of individual myosin heads, position-marked with gold particles (diameter, 20 nm) via site-directed antibodies to myosin head, and found novel properties of individual myosin heads, which are summarized as follows: In the absence of ATP, myosin heads take stable neutral position, around which they fluctuate. In the absence of actin filaments, individual myosin heads move away from, but not towards the bare region at the center of myosin filaments, i.e. they perform recovery stroke. After exhaustion of applied ATP return to their neutral position. The above finding indicates that myosin heads can sense the absence or presence of actin filament to determine their direction of ATP-induced movement, without being guided by actin filaments. In the presence of actin filaments, individual myosin heads perform power stroke in two different modes depending on experimental conditions. We emphasize that our EC experiment is the only method to visualize and record ATP-coupled movement of individual myosin heads, while all other methods can only obtain ambiguous results due to asynchronous nature of myosin head movement.