Champion jumpers

Champion jumper Jackie Joyner-Kersee set an Olympic record for the women's long jump at the Seoul Olympics in 1988.

The Olympic record for the woman's long jump is 7,4 meters, set in 1988 by Jackie Joyner-Kersee. Another world record long jump that still stands was set two years earlier by Rosie the Ribeter, who jumped 6,5 meters. Rosie was a frog competing in the Calaveras County Jumping Frog Contest. In some ways, Rosie's jump is more impressive: while Jackie's jump was about 5 times her body length (ie., her height), Rosie's was about 20 times her body length.

Jackie's jump and Rosie's jump were both powered by skeletal muscle. Muscle tissue is an effector that responds to commands from the nervous system. The molecular and cellular mechanisms of muscle contraction are essentially the same in the frog and the human, so why is the frog's jump so much more impressive? The answer involves the concept of leverage.

Both frog and human jumping muscles pull on bones that are connected at joints to make levers. A lever makes it possible for the same force to move a large mass a small distance or a small mass a large distance. The ratio of a frog's leg length to its body mass is simply greater than that of a human. Thus the frog's legs are better at moving a small mass a long distance than are the human's legs.

Let's add a flea to our interspecies Olympic competition. The flea can jump over 200 times its body length. This incredible performance is not due to feats of leverage, because no muscle can contract fast enough to explain the take-off velocity of the flea. A different effector mechanism evolved in the flea, a kind of slingshot action. At the base of the flea's jumping legs is an elastic material that is compressed by muscles while the flea is resting. When a trigger mechanism is released, the elastic material recoils and «fires» the flea into the air.

In a contest of jumping endurance, the uncontested champion would be the kangaroo. As a human runs faster, the number of strides and the energy expended per minute increase rapidly. Neither is true for the kangaroo. When moving at speeds from about 5 to 25 kilometers per hour, the kangaroo takes the same number of strides per minute and its metabolic rate does not increase. Why is this so?

In kangaroos, as in frogs and humans, the muscles used to jump are attached to bones by tendons. Like the material at the base of the flea's legs, tendons can be elastic. The kangaroo's tendons stretch when it lands, and their recoil helps power the next jump - similar to the action of a pogo stick. In order to move faster, the kangaroo simply increases the length of its stride, thereby increasing the stretch on its tendons each time it lands and the magnitude of the recoil at the initiation of each jump.

The ability to move is one of the things that distinguishes animals from the other multicellular organisms (i.e., plants and fungi). Our muscles and skeletons (the musculoskeletal system) are the effectors that produce movement.

Answer the questions

- Which animal can jump 200 times its body lenght? And how is it possible?
- Who can win a contest of jumping endurance?

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