Jamaican sprinter Usain Bolt holds the World and Olympic records for the fastest time in the 100-meter sprint. Bolt's stride, strength, and muscle coordination make him not just a biomechanical marvel, but also a gold medal favorite at the 2012 Summer Olympics. "Science of the Summer Olympics" is a 10-part video series produced in partnership with the National Science Foundation.

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Transcript
The Biomechanics of Usain Bolt
LIAM McHUGH, reporting:
It's a race people still talk about, analyze, celebrate. The men's 100-meter sprint at the 2008 Summer Olympics in Beijing. Jamaica's Usain Bolt tearing up the track as he sails over the finish line in world-record time. Crowned the "World's Fastest Human," Bolt betters his own mark a year later at the World Championships in Berlin, blazing to victory in 9.58 seconds.

USAIN BOLT (Olympic Gold Medalist): I want after the London Games people should say "wow." When they turn their TV off, sit back in their chair for a minute and think about what just happened. That's what I'm looking forward to. I wanna just "wow" people.

McHUGH: While fans admire his speed and showmanship, it's the biomechanics of Usain Bolt that intrigues mechanical engineers like Anette Hosoi, a professor at MIT who has been supported by the National Science Foundation.

ANETTE HOSOI (Massachusetts Institute of Technology): Usain Bolt is unique in that somehow he is able to both get the top acceleration and maintain the top speed.

McHUGH: Bolt is amazing because someone his size isn't expected to move so well and so fast. But the exceptional combination of his size and his strength makes Bolt unlike any champion before him. At 6 feet 5 inches, Bolt is several inches taller than most of his rivals. His longer legs give him a naturally longer stride. Other elite runners average 44 steps to run 100 meters. Bolt averages just 41 steps.

HOSOI: His stride length is enormous. So every time he takes a step he covers a tremendous amount of ground.

McHUGH: But because he is larger, Bolt has more mass than other sprinters and needs more strength - more force - to move his body. With each step, Bolt generates enormous force against the ground. The
ground applies that force back, propelling Bolt forward. Bolt moves more mass than other runners and he moves it faster.

HOSOI: The amount of force that you can give to the ground depends partially on your technique, but mostly on how much strength you have in your muscles.

McHUGH: Bigger muscles generate more force, so Bolt, like all sprinters, trains hard at the track and in the weight room.

BOLT: I work really hard now, because, I'm not really a fan of the gym, but you have to do it to get that strength, that power you need to get outta the block.

SAMUEL HAMNER (Stanford University): Strength isn't just how big is the muscle, but it's how big is the muscle and how much force can it produce while it's moving.

McHUGH: How the muscles function during motion is part of the research conducted by Samuel Hamner, a mechanical engineer at Stanford University who has also received support from the National Science Foundation. Hamner collects data in a motion-capture room using infra-red cameras and sensors, and creates dynamic simulations, information that can help treat movement disorders and also help athletes optimize their performance.

HAMNER: If we can understand what the functional roles of these muscles are, it might help Usain Bolt change his training or better understand how he can become faster.

McHUGH: Hamner explains that as Bolt sprints down the track, more than 30 muscles in each leg work together in complex coordination during the two phases of the running gait-- the "stance" phase and the "flight" phase. In the "stance" phase, Bolt has at least one foot on the ground.

HAMNER: When your foot first hits the ground, you are actually slowing down, you're braking your body. And you're using muscles in your thigh called quadriceps to actually slow you down and support your weight while you are coming into contact with the ground. In the second half of the stance phase, you start then accelerating your body forward again. And this time you're using some different muscles, your calf muscles, to push yourself up and accelerate you forward as you then lift off into the flight phase.

McHUGH: In the "flight" phase, Bolt has both feet off the ground. His hamstring muscles on the back of the thigh pull the leg down before his foot hits the ground again. The flight phase showcases Bolt's superior stride length - he's in the air longer, flying farther with each powerful step.

HAMNER: So, there's actually kind of very precise actuation of each of the muscles when you’re running. If you are off by a few milliseconds when you're generating these forces, you'll fall over or you'll injure yourself. So, it takes precise timing of the electrical signal that comes from your brain to your muscle to create that force.

McHUGH: If Usain Bolt is at his biomechanical best, he could turn in another spectacular time in London's Olympic Stadium.

BOLT: For me it's just the strength and the length of my stride, everything comes together which makes it look so superb.

McHUGH: And when it all comes together, it's a thrilling race to the finish line.