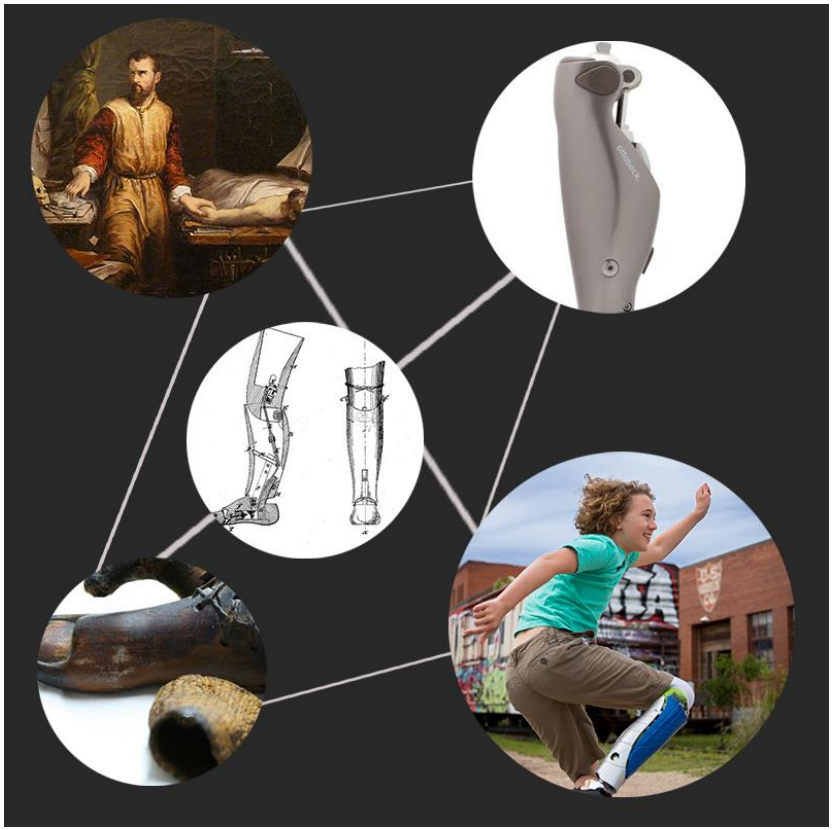
The Future of Motion:
Technologies for Prosthetic Limbs



Robert P Weinberg

DayCon 2016

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Our Roadmap

1. Normal body motion – the muscles

2. Synthetic body motion – prosthetic limbs

    a. History of prostheses

    b. Technology for prosthetic limbs

3. Daily life with a prosthesis

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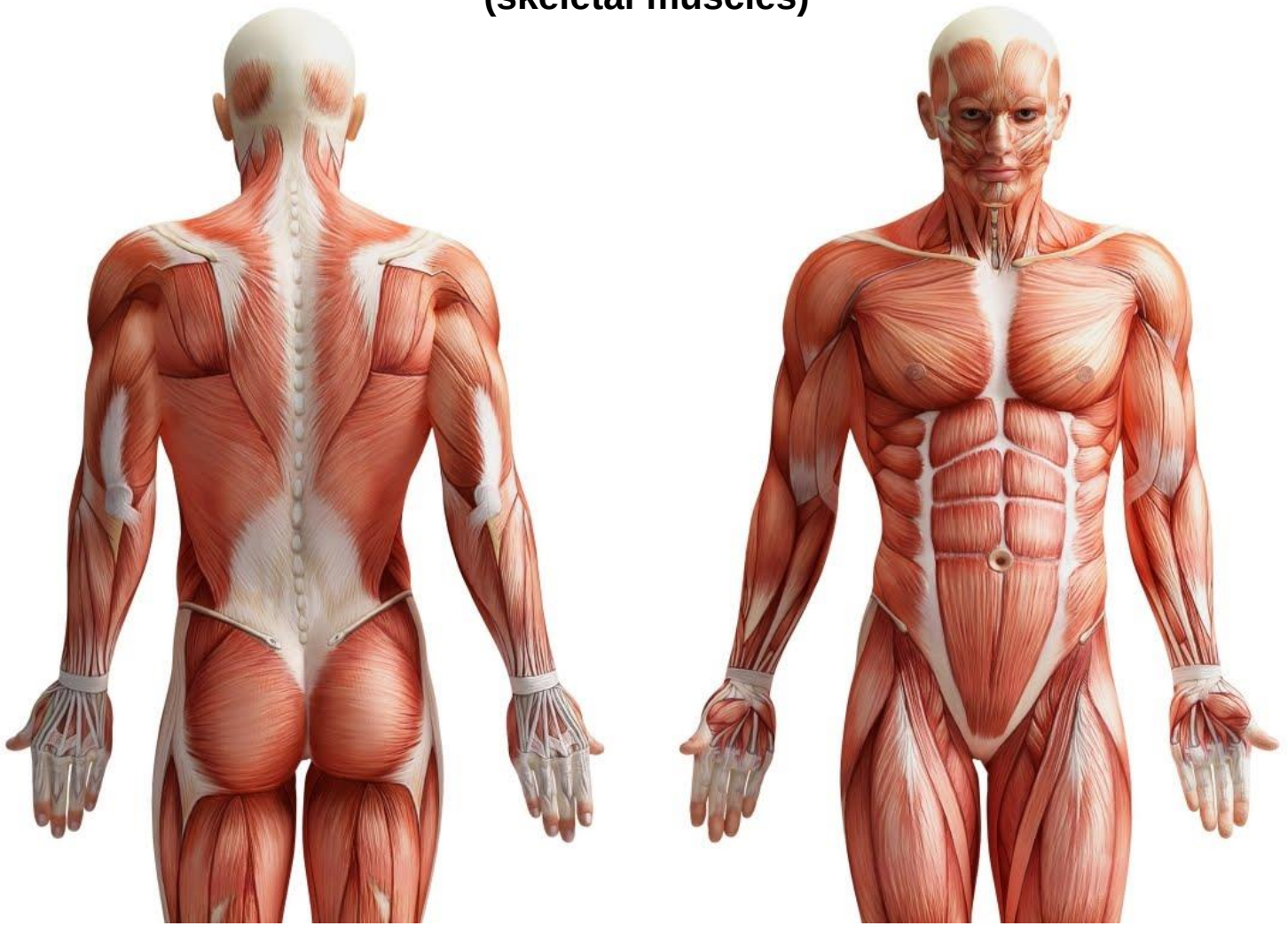
There are over 700 muscles in the human body

(skeletal muscles)

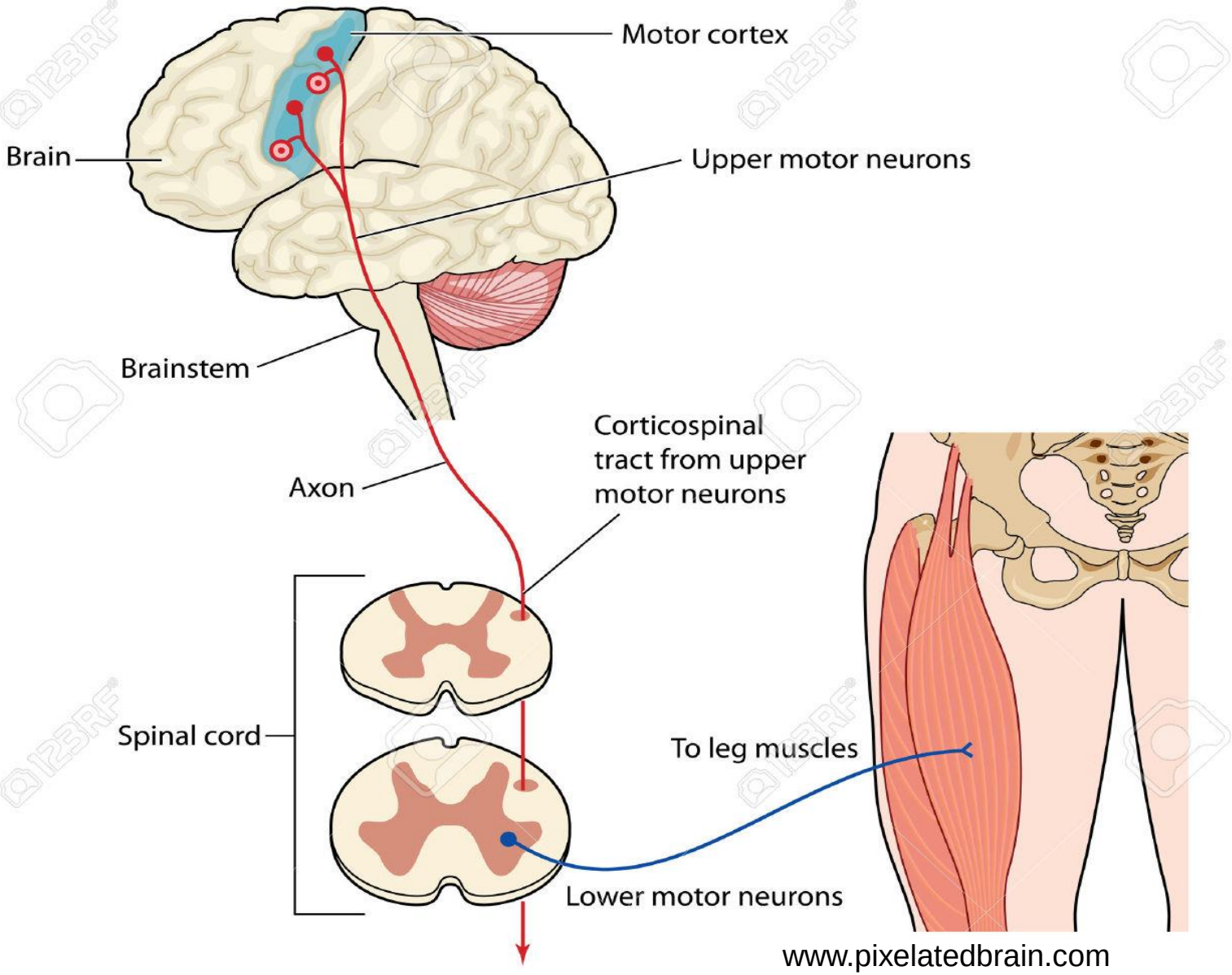


Netter, Musculoskeletal System

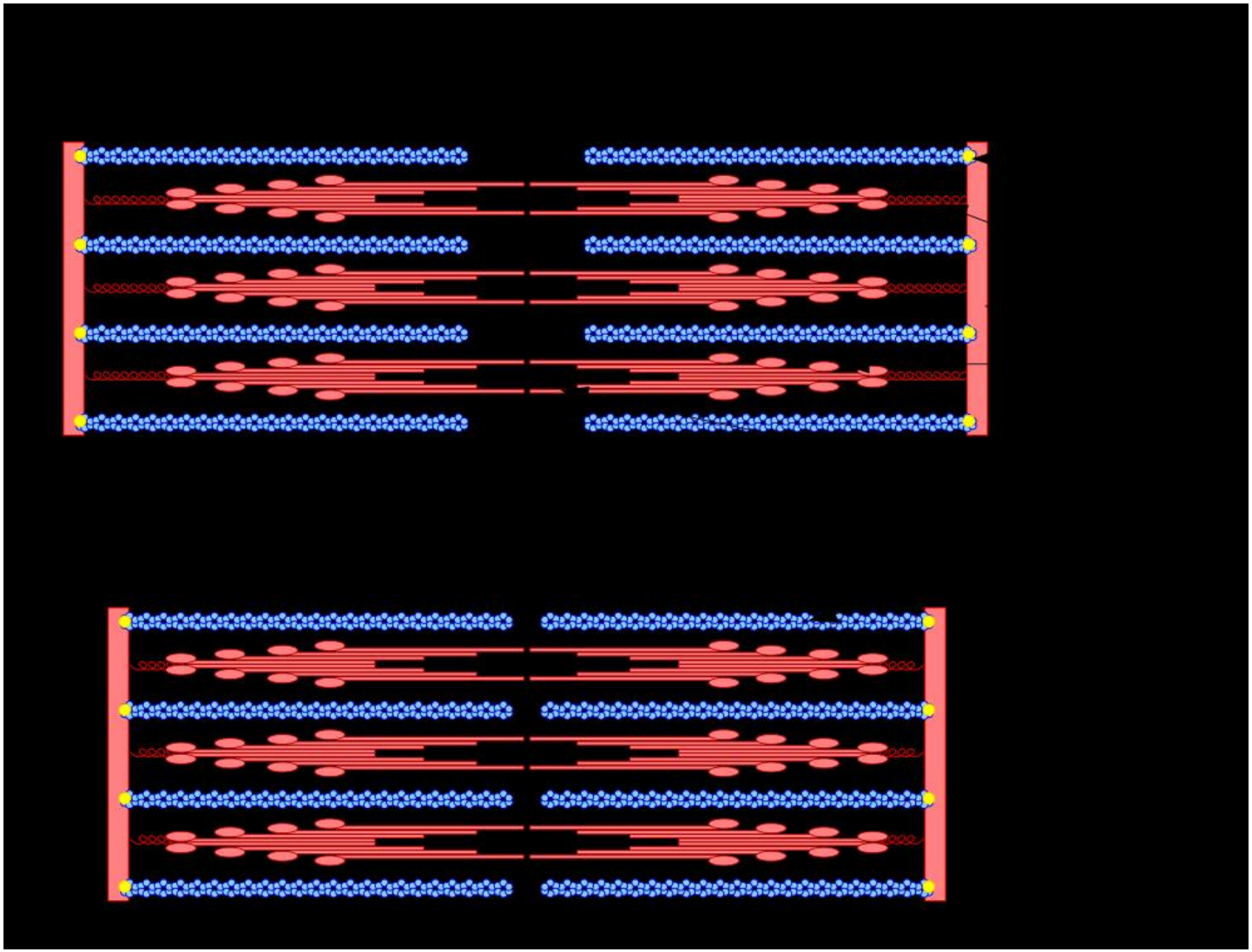
Muscles produce movement through contraction

Bill Geiger, Muscle and Fitness

Switchboard in brain sends electric impulse to muscle



Sarcomeres - actin & myosin filaments contract



Guyton's Textbook of Physiology

Muscle contracting

www.youtube.com

Questions?

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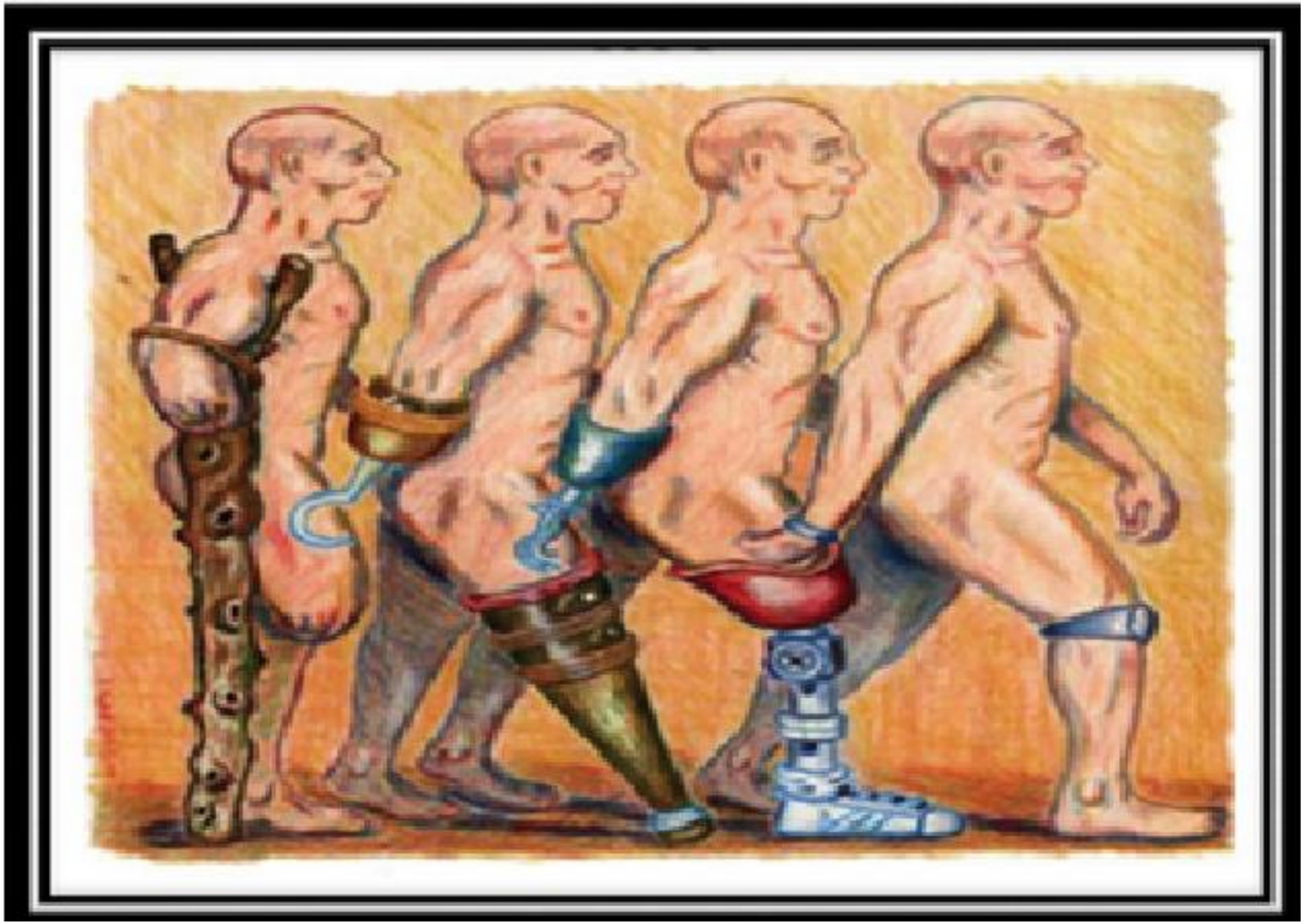
Evolution of limb prostheses over the centuries



Kim Norton, A Brief History of Prosthetics

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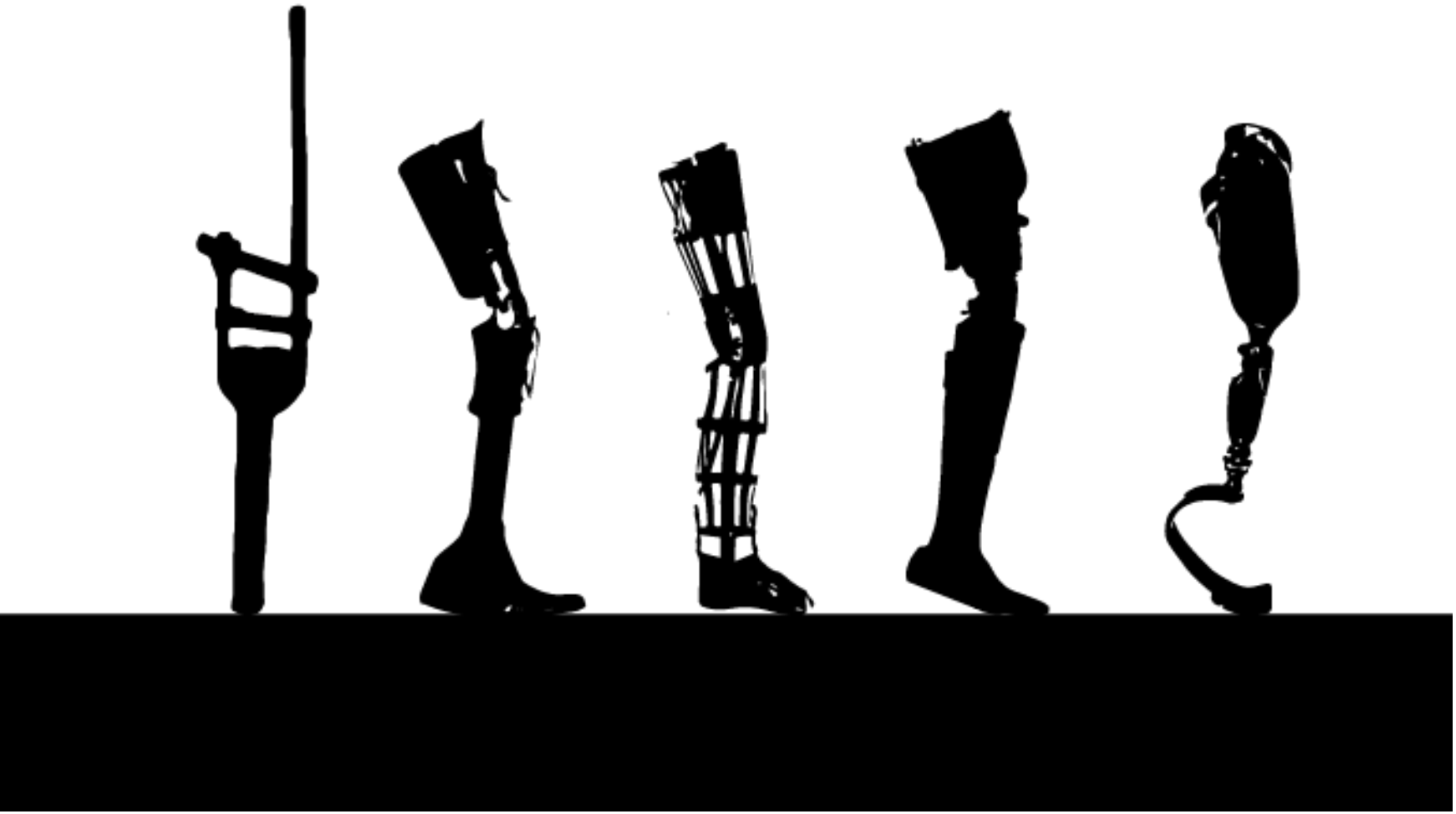
Prosthetic limbs with improved function



ExploraVision Project Website

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From stick to robotic limb

ExploraVision Project Website

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3,000-year old prosthetic toe of Egyptian noblewoman

Alexis Douglas, Advancement of Prostheses throughout history

French Surgeon James Bertrand Ambroise Pare

Commons.wikimedia.org

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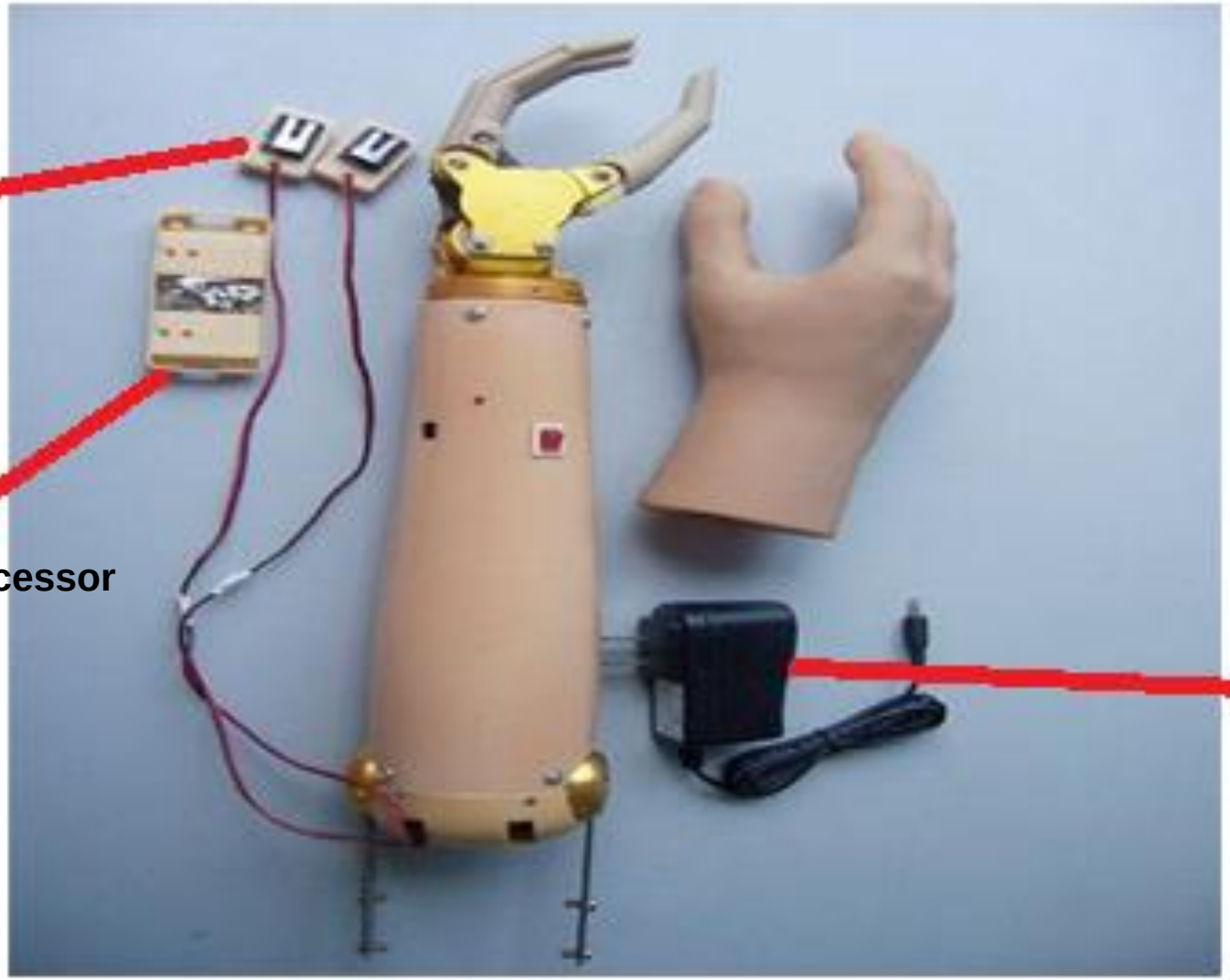
How to engineer a prosthetic limb

- Basic parts should include:
  - Sensors – to detect intended motion
  - Microprocessor – to integrate input and output
  - Motors – to move mechanical parts

Basic parts of earlier prosthetic arm/hand



Alexis Douglas, Advancement of Prostheses throughout history

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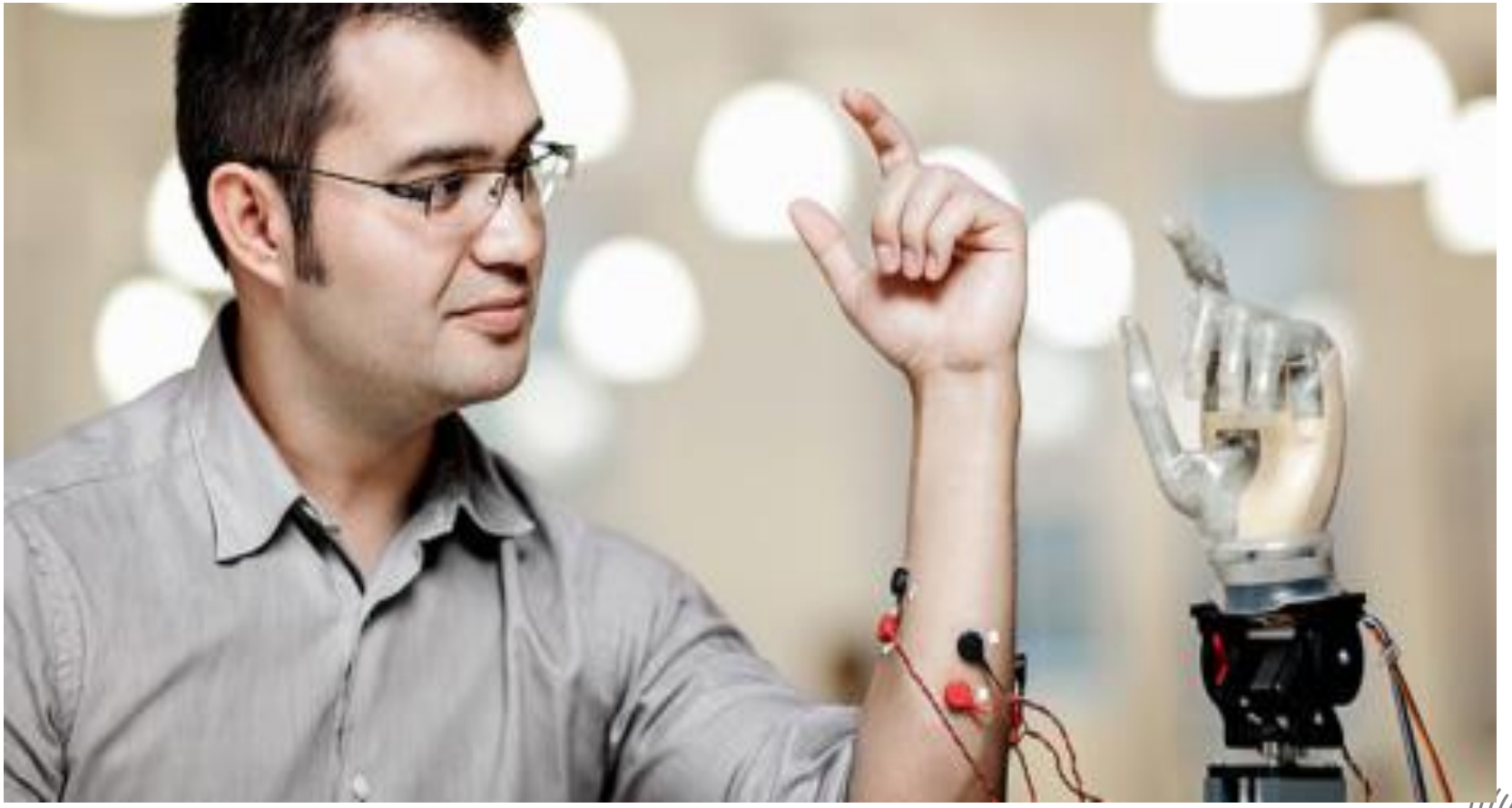
Muscles generate impulses to direct robotic arm



Editor, Medgadget.com

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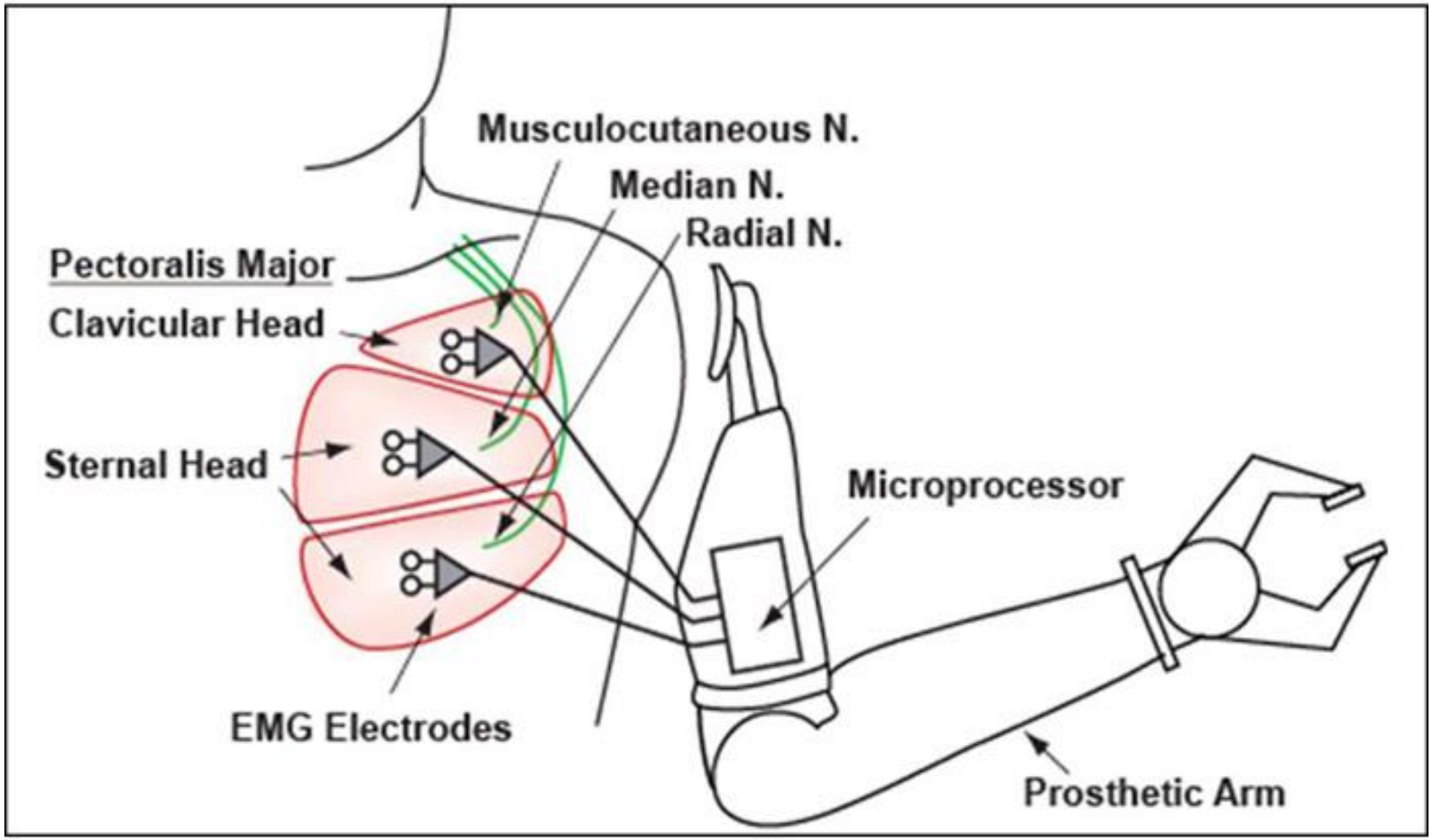
Prosthetic sensors and microprocessor



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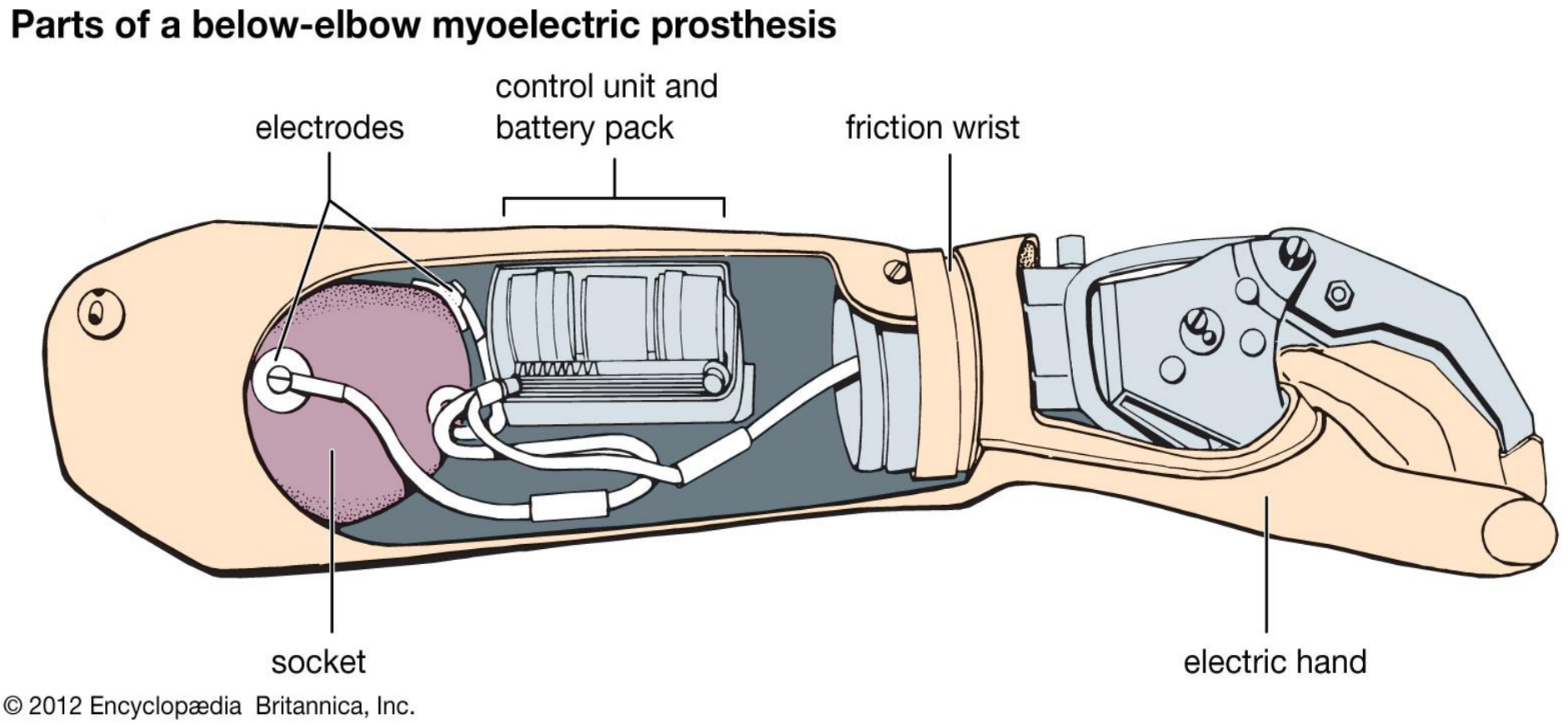
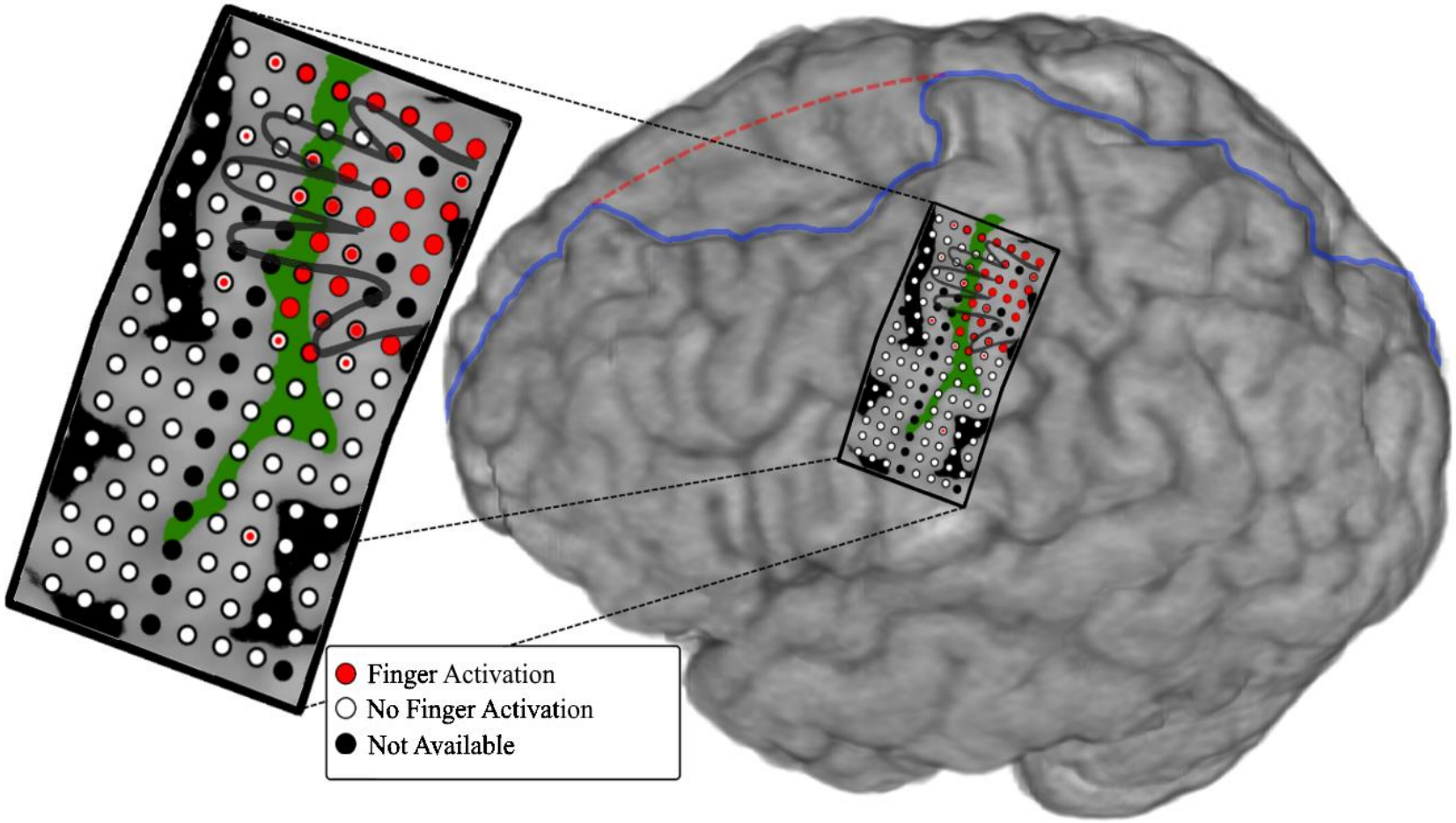
Myoelectric prosthesis



Newer prostheses can be controlled directly by the brain



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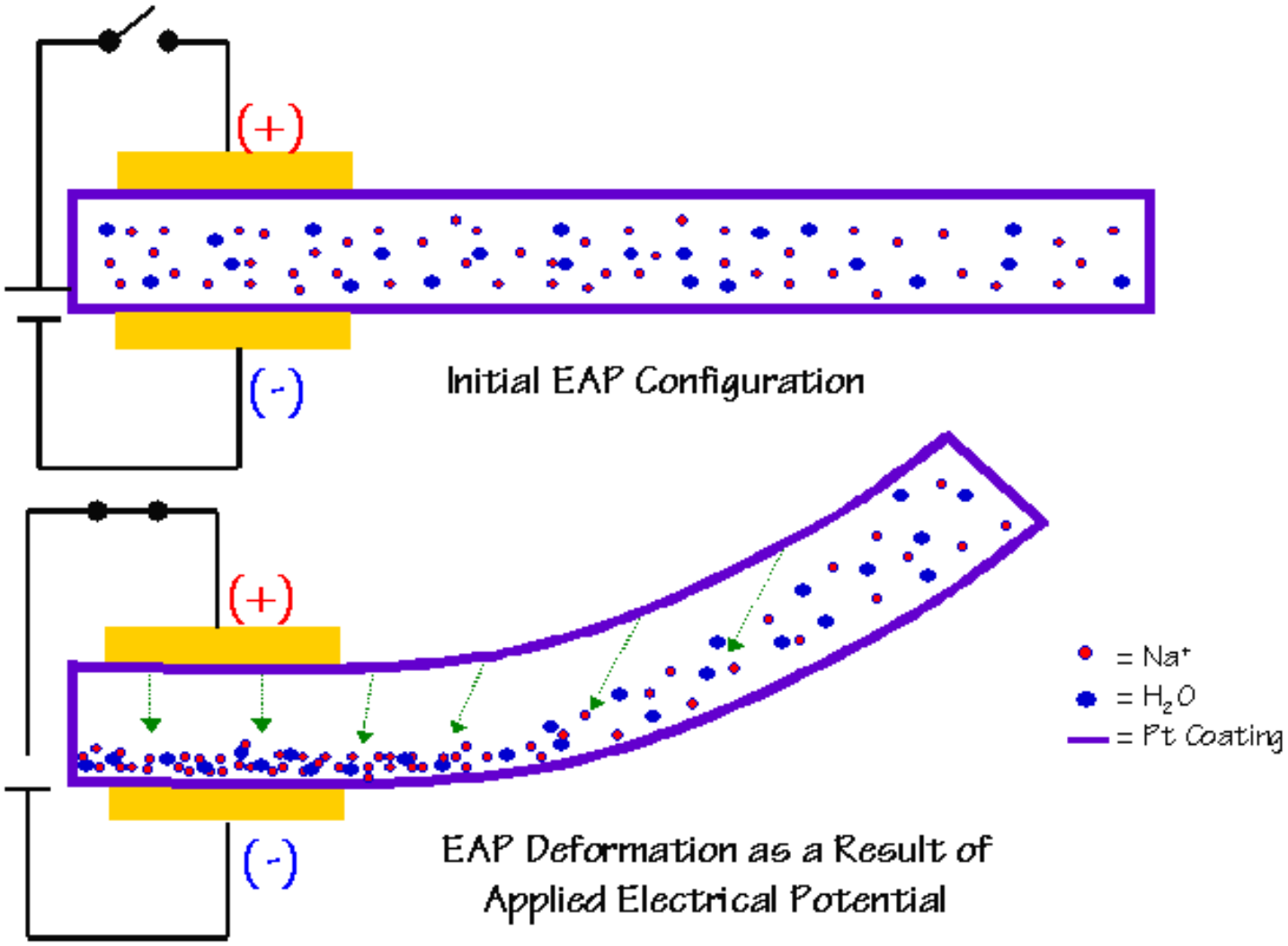
Artificial muscles from chemical polymers which contract with current



Drs Olazabal and Sansinena

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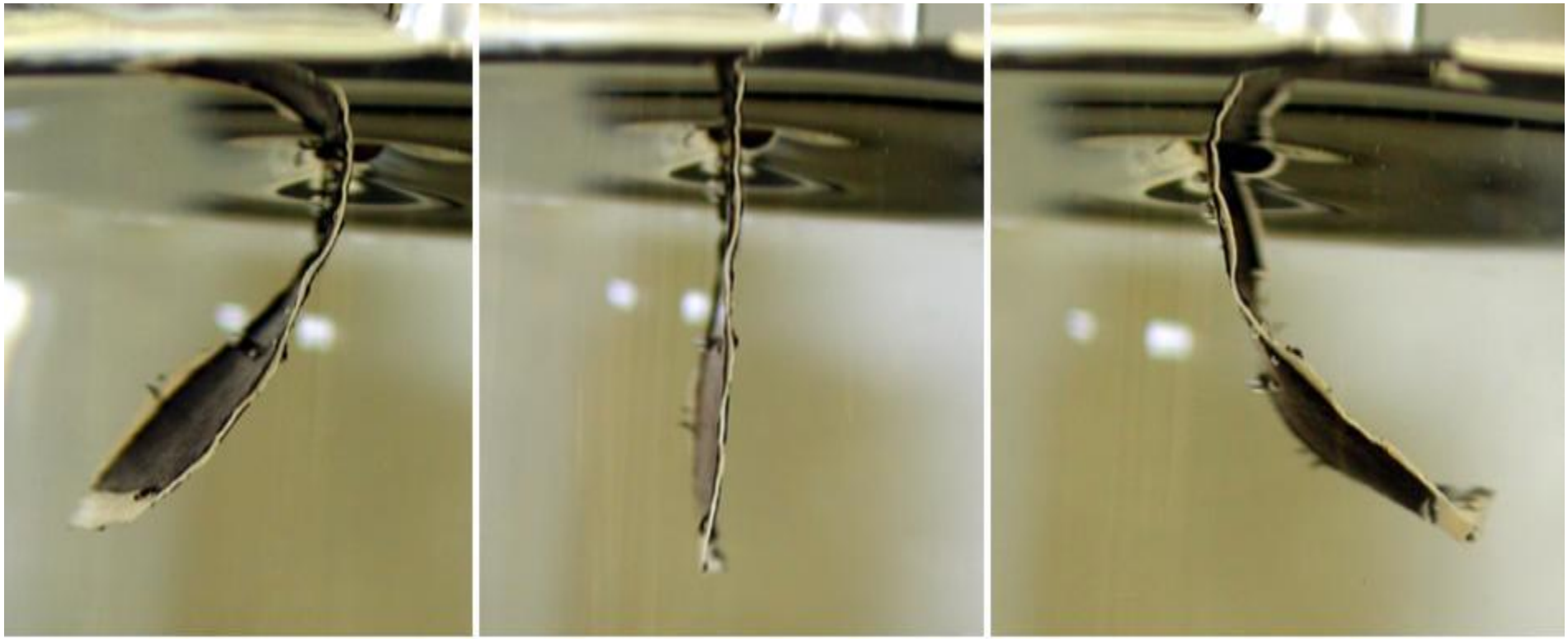
Polymer contracting to left then to right upon application of electric current



Conductive polymers at JPL (produced by Drs. Olazabal and Sansiñena)

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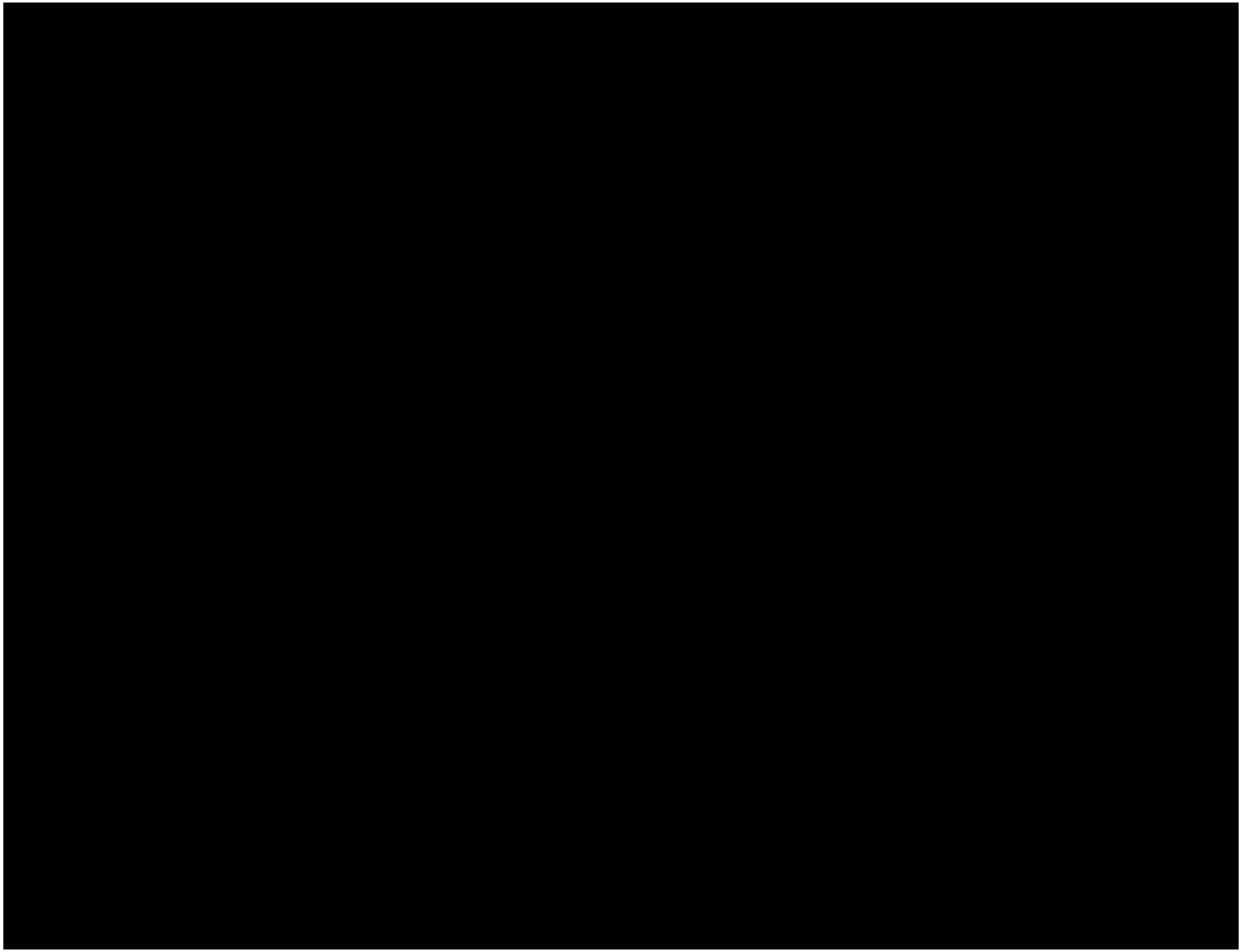
Advanced DARPA bionic arm



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Playing soccer with prosthetic legs

Jane Irving, Forbes

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Running races with prosthetic legs

Chelsea Whyte, New Scientist

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Paralympic sprinters running race

Chelsea Whyte, New Scientist

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Rock climbing with 2 prosthetic legs!

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Advanced prosthetic leg following shark attack

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Champion fuzzboll player with 2 prosthetic arms

Wikipedia – “prosthesis”

Prosthetic legs from age 1 through 4 years

Hogan and Herr, Augmenting Humanity

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“I’ll be back”

Arnold Schwarznegger, “The Terminator”

Questions?

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Thank you!

SITN would like to acknowledge the following organizations for their generous support.

Harvard Medical School
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The Harvard Biomedical Graduate Students Organization (BGSO)

The Harvard/MIT COOP