technology today

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The Biological Supercapacitor

Don't you hate it when your smartphone runs out of power when you need it the most? To alleviate this low-power catastrophe, you probably carry a back-up battery, and a charging cable, to keep your smartphone off life support (power saving mode). As much a pain as the above scenario might be, imagine how a person feels when they are told that the battery in their pacemaker needs to be replaced, and this battery update requires surgery.

In the 50+ year history of pacemakers, the device, and its battery power source, have seen many improvements. It has shrunk dramatically in size so it is now about the size of a U.S. 50¢ coin, with about half of that real-estate taken up by its battery. The pacemaker's battery powers the electrical stimulation that is necessary to correct the patient's irregular heartbeats.

A recent materials science breakthrough of a new biologically friendly electrical energy storage device might soon be able to replace the battery now found in pacemakers (Photos 1 & 2). This new electrical storage device is completely made up of materials that are biologically compatible with our internal chemistry. It won't cause infections, or allergic reactions, making it perfectly safe for it to be used inside animals or people to power medical devices. The researchers that developed the technology also indicate it should never need to be replaced since it has no parts that can wear out or, over time, lose its ability to hold an electrical charge.

Images courtesy Islam Mosa, University of Connecticut, and Maher El-Kady, UCLA

Photo 1—Artist rendering shows what a 3D image of a patient's working heart might look like during a medical scan to see if the pacemaker, and its biological supercapacitor, are functioning properly.

The biological supercapacitor was developed in a joint project that was funded by the National Science Foundation and other bioengineering and health institutes. Scientists at UCLA and the University of Connecticut worked together to develop what they are calling a biological supercapacitor that could soon make implanted medical devices work without a battery.

A capacitor is an electrical device that can store electricity for short periods of time. It cannot store as much energy as a battery, so capacitors need to constantly be re-energized. To keep their biological supercapacitor ready to perform its electrical stimulation of the patient's heart, it is constantly being recharged to full capacity. The electrical energy to recharge it comes from the electrolytes of the animal,

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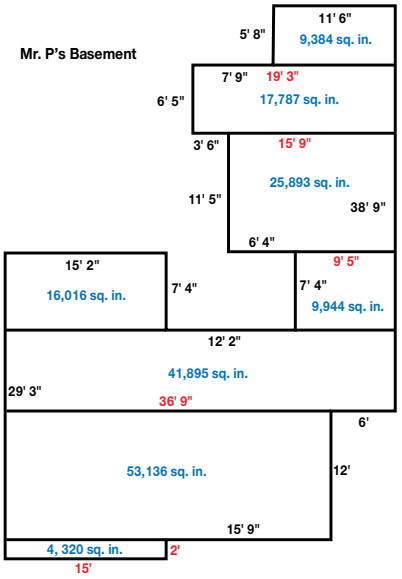
More than Fun Answers

Problem Basement

First, determine the lengths of the two sides of the basement that were left blank. The length of the bottom segment is 15' and the length of the small vertical segment is 2'.

Divided the basement into rectangles and then find their areas. First, convert all the lengths to inches. See the diagram below (the areas are given in blue, the missing sides in red).

The total area is 178,375 square inches or 1,238.7 square feet.



Word Scramble Challenge

INPUT	OXYGEN
MITER	SALIVA

When unscrambled, the letters in the squares read:

IMAGINATION

Albert Einstein once quipped: "Imagination is more important than knowledge" How far would he have reached without it?

Changing Times

You need 9 coins:
4 pennies, 1 nickel, 2 dimes, 1 quarter, 1 half dollar, or
4 pennies, 2 nickels, 1 dime, 1 quarter, 1 half dollar.

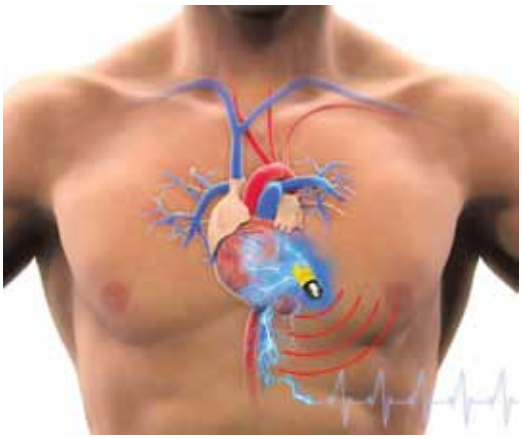


Photo 2—If animal and human trials have positive results, a biological supercapacitor might one day remove the need to use batteries inside the human body to power pacemakers and other medical devices.

or human body's, biological fluids.

To always guarantee enough energy for recharging, they also developed a small energy harvester. Energy harvesting is the process of scavenging energy from an existing energy source. For example, solar panels generate electricity from sunlight which makes solar panels an energy harvester. The energy harvester, installed alongside the biological supercapacitor, converts body heat, and physical motion, into electricity.

The team built their supercapacitor using layers of graphene, and human proteins, so their device contains no ingredients which are not biologically compatible with the human body. It is the inclusion of human proteins that makes the supercapacitor a biological device. Graphene is a one-atom-thick sheet of carbon that is harder than a diamond, unbelievably flexible, and a great conductor of heat and electricity. It was discovered in 2004 and it is currently finding its way into all kinds of new and even old technologies.

Without any other viable power source available, batteries have been used in pacemakers even though they contain chemicals and metals that could be toxic if the battery leaks. But just like your smartphone battery, all batteries eventually lose their ability to hold a charge. Since all surgeries have chances of infections, an electrical power system that won't need replacement would certainly be superior to one that might leak and/or eventually wear out, creating the need for emergency surgery.

Before this technology is approved for people it will need to go through more animal testing, and eventually human trials. If testing goes as planned, you can expect many new implantable medical devices will use biological supercapacitors, and energy harvesters, as their power source.

Taking It a Step Further

Working in teams of three or four, research how graphene is being used today. Also identify all the different ways we harvest energy from existing natural or human-made systems. td