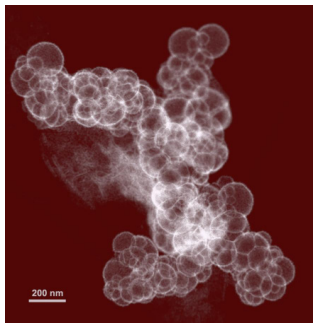
# news briefs

## Costly Catalysts and Emerging Alternatives

**Diesel has a** carbon content of 2,778 grams per gallon, in comparison to gasoline, which has a carbon content of 2,421 grams per gallon (1). Nearly 50% of personal vehicles in Europe run on diesel. In America, diesel has a variety of industrial uses, like fueling freight vehicles. But despite its high energy efficiency and widespread use, diesel requires engines to operate under high-oxygen conditions (2). The nitrogen compounds that emerge from its combustion are therefore more difficult to remove than when using gasoline, because there is not an equal presence of oxidizing and reducing agents. A critical step in reducing NO emissions is the conversion of NO to $NO_2$ (oxidation), in order to generate a 1:1 ratio of NO:$NO_2$ (2). In diesel engines, this step is typically achieved via a costly platinum catalyst.




credit: http://www.bnl.gov/bnlweb/pubaf/pr/photos/2009/05/PlatinumCatalyst-300.jpg

Figure 1. A fuel catalyst made of platinum and paladium.

A team led by Wei Li, from the General Motors Global Research and Development group, investigated the use of catalytic perovskite oxides in place of platinum and found nearly equal NO conversion efficiency. Perovskite oxides are compounds of the form $ABO_3$, where A is a cation of an alkaline or rare-earth metal, and B is a cation of a transition metal. They have generated much interest because of their resistance at high temperatures and their low cost (2). Using a photoelectron spectroscopy citrate process at high temperatures, Li et al. found that the reaction using the perovskite catalysts took place at a significantly faster rate than those using platinum catalysts (2, 3). Further research and potential implementation of this promising discovery into vehicles could yield significant reduction in the costs of diesel fuel after treatment.

*—Julia Ransohoff'13 is a prospective Human Developmental and Regenerative Biology concentrator in Pforzheimer House.*

1. "Emission Facts: Average Carbon Dioxide Emissions Resulting from Gasoline and Diesel Fuel." U.S. E.P.A. (2005) <http://www.epa.gov/otaq/climate/420f05001.htm> [Accesed 5 May 2010]
2.Kim, C.H. et al., *Science* **327**, 1624-1627 (2010).
3. Ponce, S. et al., *Applied Catalysis B: Environmental* **24**, 193-205 (2000).

## Decoding the Neanderthal Genome

**Today we are** alone. There is no other species on Earth that we can truly call "human." But that was not always the case. Until about 30,000 years ago, a sister group of the *Homo* genus, Neanderthals, existed concurrently with modern humans (2). Did Neanderthals and *Homo sapiens* interact with each other? Why did one group die out and the other thrive? Scientists have struggled to answer these questions for decades. A new research project led by Max Planck Institute Professor Svante Pääbo and Harvard Medical School Professor David Reich sheds new light onto these questions by examining the Neanderthal genome (2).

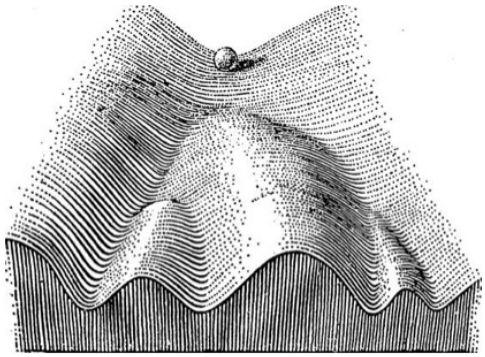
Analyzing ancient genomes is a very difficult process. The samples are small and degraded, and the risk of contamination is complicated because of the genetic similarity between us and Neanderthals. Due to these constraints, only small parts of the Neanderthal genome had been previously sequenced. By improving upon these techniques, Green et al. have successfully completed a draft Neanderthal genome sequence of over 4 billion nucleotides. They found that present-day human populations of Eurasian descent have more genetic polymorphisms in common with Neanderthals than do people of sub-Saharan African descent. This implies that Neanderthals interbred with anatomically modern humans after they left Africa, although probably infrequently. Analysis of differences in the genomes between modern humans and Neanderthals also found genes mediating traits like cognitive ability, which may have enabled *Homo sapiens* to survive when Neanderthals did not (1).

*—Lauren Schumacher '10 is a Molecular and Cellular Biology concentrator in Leverett House.*

1. Green, R. et al., *Science* **328**, 710 (2010).
2. Cameron, D. "Neanderthal Genome Tells a Human Story." HMS Press Release (2010) <http://hms.harvard.edu/public/news/2010/050610_reich.html> [Accessed 15 May 2010]

# news briefs

## Transdifferentiation of Skin Cells into Heart Cells



credit: Conrad Hal Waddington. "The strategy of the genes: A discussion of some aspects of theoretical btial biology." Macmillan, 1957.

Figure 1. Waddington's Epigenetic Landscape.

**More than fifty** years ago, Conrad Waddington first conceived the idea of an "epigenetic landscape" as a means to understand how cells become increasingly specialized during development (Figure 1). We now know that this landscape represents modifications of the genetic material in immature cells that progressively limit their ability to differentiate into mature cell types. Like a marble rolling down a grooved slope, cells can become increasingly specialized over time. Once a cell has reached a mature, differentiated state, it is difficult to push it back up the hill to a less differentiated state or to transform that mature cell into a different type of cell ("transdifferentiation"), without first passing through a stem cell intermediate.

A recent report published in *Cell* by researchers at the Gladstone Institute of Cardiovascular Disease utilized transdifferentiation to turn skin cells directly into cardiomyocytes, the cells responsible for the heart's contractions, by expressing a combination of three genes (1). A group led by Shinya Yamanaka first illustrated in 2006 that mature cells could be reverted to a pluripotent-like state, called induced pluripotent stem (iPS) cells (2). This discovery led to a great deal of interest in creating iPS cells from a patient's own mature cells, following which they could be differentiated into functional mature cells for therapy. This report is exciting because heart cells were generated without going through the iPS cell transition.

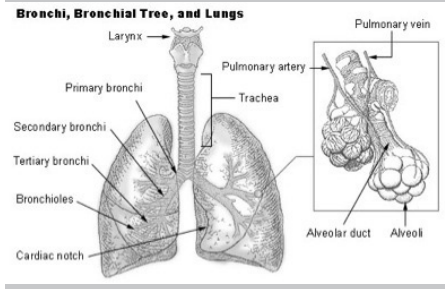
Heart disease is the leading cause of death in the United States, so the ability to repair heart muscle damaged after a heart attack, for example, would greatly improve clinical outcomes. One possibility is that other cell types that are found in the heart could be recruited to regenerate cardiomyocytes and restore function (1). While the dream of regenerating the heart remains elusive, this study and future research will better define the most achievable route for regeneration.

*—Anirudh Penumaka '12 is a Chemical and Physical Biology concentrator in Adams House.*


1. Ieda, M. et al. "Direct Reprogramming of Fibroblasts into Functional Cardiomyocytes by Defined Factors." Cell. 142: 3, 375 – 386. August 2010.

2. Takahashi, K. et al. Induction of pluripotent stem cells from mouse embryonic and adult fibroblast cultures by defined factors. Cell. 126: 663–676. August 2006.


## Microfluidic Model of the Human Lung




credit: http://training.seer.cancer.gov/anatomy/respiratory/passages/bronchi.html

**A group at** the Harvard Wyss Institute recently reported the creation of a chip-based, microfluidic system that replicates many of the properties of the human lung. Oxygen and carbon dioxide are normally exchanged across the epithelial cells of the alveoli in the lungs, after which these gases diffuse across thin walled capillaries to enter or leave the blood. Huh et al. were able to introduce both epithelial cells of the alveoli and endothelial cells of the capillaries surrounding the alveoli onto opposite sides of a membrane in the device. The membrane on which the cells were cultured could then be stretched to mimic the displacements that occur during breathing (1).

This system reflects many of the mechanical forces that are normally found in the lungs; however, it also displays several complex immunological responses to situations such as bacterial invasion and inflammation when immune system cells are introduced. The fact that this device houses multiple cell types in a setting very similar to the environment found in the body represents a major advance in the design of an artificial model of an organ system (1).

Some important applications of this technology would be to study the effects of drugs that are used to treat certain respiratory diseases, to analyze the effects of toxins in the atmosphere, or as an alternative to animal testing. The authors also propose the interesting possibility that several of these artificial systems could be connected in the future to develop an understanding of the interaction between organs, and their responses to various pharmaceuticals (1).

*—Anirudh Penumaka '12 is a Chemical and Physical Biology concentrator in Adams House.*


1. Huh, D., et al. "Reconstituting Organ-Level Lung Functions on a Chip." Science. 328: 5986, 1662 – 1668. June 2010.