Sound of Science
理聲
Newsletter of Science Promotion Team
January, 2011 二零一一年一月號

Like poison for phosphorus

You may not know phosphorus when you see it, but your body does. Phosphorus is a sturdy workhorse element. In DNA molecules, phosphorus helps support the whole double helix. Within cells, energy shows up as ATP — and the "P" stands for phosphorus (specifically, phosphate, a form of phosphorus).

All life as we know it, in other words, depends on phosphorus. For that reason, scientists around the world were shocked December 2 when a team of scientists announced finding life forms that didn't necessarily depend on this all-important element. In laboratory tests, the scientists grew bacteria that were able to use arsenic — a different element with similar chemistry — in the place of phosphorus.

It's a surprising discovery because living organisms have never been found without all six of the ingredients crucial to life: carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur (all together known as CHNOPS). Arsenic, though, is a potentially fatal poison.

Scientist Felisa Wolfe-Simon found the bacteria by taking samples of the muds of California's Mono Lake.

Mono Lake in eastern California is where researchers found a type of bacteria that appears to break the rules for how we think life should survive.

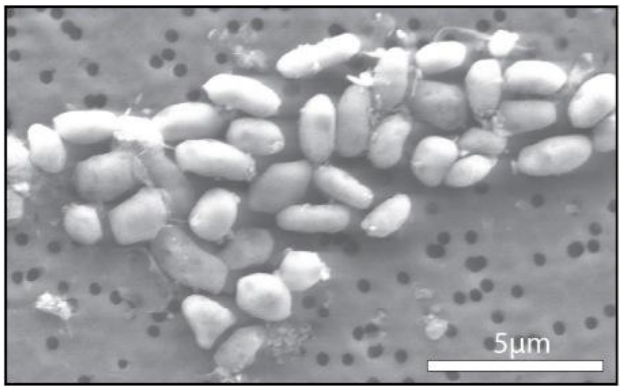
Many scientists say they would like to see more evidence that the research team did in fact observe life forms using arsenic instead of phosphorus.

"This is an amazing result, a striking, very important and astonishing result — if true," Alan Schwartz told *Science News*. Schwartz researches chemistry at Radboud University Nijmegen in the Netherlands. "I'm even more skeptical than usual, because of the implications. But it is fascinating work."

The bacteria came from Mono Lake, a lake in eastern California that is well known for its unusual population of living organisms, including shrimp and algae. The lake doesn't drain, so the only way for water to leave is through evaporation. As a result, the lake is much saltier than the ocean.

Several researchers had been studying a number of tiny organisms that lived in Mono Lake mud. Astrobiologists study life in the universe and want to know how it started, how it has changed, and what will happen to life in the future. They also want to know whether life exists on other planets and if so, what it might look like. Many astrobiologists study what lives in Earth's strangest places, such as Mono Lake, as a way to understand the possibilities for life.

The study was led by Felisa Wolfe-Simon of NASA's Astrobiology Institute and the U.S. Geological Survey in Menlo Park, Calif. She and her team removed organisms from the Mono samples and grew those bacteria in the lab. The scientists fed the microbes with sugar and vitamins — but left out phosphate. Then they changed the diet again, and gave the microbes arsenate, which is a form of arsenic.



An up-close picture of the bacteria GFAJ-1 grown on arsenic.

In one type of bacteria, called GFAJ-1, the researchers observed that arsenic wasn't fatal. The bacteria continued to grow, though not as fast as if they'd had phosphorus. After studying these bacteria, Wolfe-Simon and her team concluded that the organisms had begun to make use of the arsenic the way they usually used phosphorus.

The researchers suggest that arsenic was being used as a building block in the bacteria's DNA. "This microbe, if we are correct, has solved the challenge of being alive in a different way," Wolfe-Simon told *Science News*.

If the scientists are right, then "life as we know it" may not include *all* the life that actually is possible. For astrobiologists, that conclusion suggests that life on other planets may not necessarily look like life on Earth.

It's possible that follow-up studies will show that the researchers were mistaken. Wolfe-Simon and her team could not get rid of all the phosphorus when they were growing the bacteria. Some scientists say minute amounts might be enough to keep the microbes alive. It's possible that, in the experiment, the bacterium GFAJ-1 was still getting small amounts of phosphate.

Can life exist using poison instead of phosphorus? Life of a different type is an exciting prospect, so stay tuned to see how the scientific community reacts. Next up, scientists will want to know how, exactly, the arsenic substitution works.

POWER WORDS

1. **Arsenic**: A highly poisonous metallic element having three allotropic forms, yellow, black and gray, of which the brittle, crystalline gray is the most common. Used in insecticides.
2. **Phosphorus:** A highly reactive, nonmetallic element occurring naturally in phosphates.
3. **DNA:** A nucleic acid that carries the genetic information in the cell. DNA consists of two long chains of nucleotides twisted into a double helix and joined by hydrogen bonds between the bases.
4. **Molecule:** A group of like or of different atoms held together by chemical forces.
5. **Microbe:** A minute life form; a microorganism, especially a bacterium that causes disease.
6. **Bacterium:** A life form that is a single cell and too small to see without using a microscope. *Bacteria* (plural of *bacterium*) live in almost every environment on Earth, including very cold places, very warm places, in all types of water, in the air, even on and in plants and animals. These microorganisms can also cause disease in plants and animals.

Science Quiz (科 CEPT)

Questions are posted on the notice board of Science Promotion Team near the Staff Common Room. For more details, please refer to the notice board.

Science Promotion Team 2010-2011:

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Website: http://210.3.43.253/~lck/science/spt1011/spt1011.htm

科學專題常識問答比賽(科 CEPT)問題精選

1. 以下哪些元素不屬於稀土元素?

Ⅰ. 釷　　Ⅱ. 鈁　　Ⅲ. 鈥　　Ⅳ. 釩
Ⅴ. 鈧　　Ⅵ. 銪　　Ⅶ. 鍩　　Ⅷ. 釓

A. Ⅰ、Ⅲ、Ⅵ
B. Ⅱ、Ⅲ、Ⅳ
C. Ⅰ、Ⅳ、Ⅶ
D. Ⅵ、Ⅶ、Ⅷ

2. 稀土元素通常分為哪二組?

Ⅰ. 輕稀土　　Ⅱ. 重稀土　　Ⅲ. 磁鐵稀土　　Ⅳ. 氧化稀土

A. Ⅰ、Ⅱ
B. Ⅰ、Ⅲ
C. Ⅰ、Ⅳ
D. Ⅲ、Ⅳ

3. 兩隻褐色毛的兔互相交配，產生的四隻小兔中有一隻為白色，三隻為褐色，根據此一結果推測，白色毛不可能是顯性，因為白色毛若為顯性，則

A. 親代雙方必須均為白色
B. 親代中至少一方須為白色
C. 所有的後代皆為白色
D. 後代中必須有 1/4 為白色

4. 在演化上有性生殖較無性生殖有利，因為有性生殖

A. 對種族性狀的延續貢獻較大
B. 使後代的性狀與親代完全一樣
C. 使基因重組機會增加
D. 可大量增加後代數目

應用科學：血液中的年齡標記

科學家在人類血液中發現年齡的標記，有助於刑事鑑識專家對採集到的樣本，作出犯人或受害人更詳細的描述。

傳統上，刑事鑑識專家從犯罪現象採集到了血液，會利用萃取出的 DNA 來比對資料庫裡的蒐藏。對資料庫中未建檔的樣本，刑事鑑識專家也試圖從 DNA 中搜尋更多的資訊，例如犯人眼球的顏色等等。荷蘭鹿特丹伊拉斯謨大學醫學中心的遺傳學家 Manfred Kayser 等人發現，血液樣本還包含了主人的年齡訊息。他們從血液中的 T 細胞發現了年齡的標記，準確率在十年以內。在這之前，刑事鑑識專家僅能夠從骨骼樣本判斷年齡。

他們搜尋了和血液年齡分子標記有關的科學文獻後發現，製造 T 細胞的胸腺會隨著年齡的增長而讓脂肪組織給取代，而此過程會留下遺傳標記。

T 細胞是淋巴細胞的一種，在免疫反應中扮演著重要的角色。T 細胞在胸腺內分化成熟，成熟後移居於周圍淋巴組織中。當 T 細胞成熟時，會重組 DNA 以製造多樣的細胞表面受器來辨識不同外來分子，此舉會留下切除的 DNA 會形成圈狀構造。Kayser 指出，DNA 圈僅存在於新生的 T 細胞，因此能夠當作胸腺老化的標記。

於是 Kayser 等人量化了 195 位從幾週大到 80 幾歲的荷蘭人的 T 細胞 DNA 圈的數量，然後和生物年齡作比較。他們發現，雖然並非十全十美，但是他們可以在 9 年的誤差內估算出一個人的年紀。如果把人群以廿年為一個年齡層來看，他們量化出的數據，能夠提供相當準確的估算。

Kayser 表示，他並非認為當就從估算出嫌犯的大概年紀，就能破解許多懸案，可是如果合併其他標記，就可能排除一些可能的嫌犯。而且，此方法也有助於鑑識專家鑑定災難的受害者；田野生態學家也可以用此方法用動物遺留下的血液來鑑定牠們的年齡。

Kayser 指出，不過在能夠實際應用之前，科學家仍需收集其他族裔的資料以作出更精確的估算。不過，有些疾病，例如愛滋病和糖尿病等，會干擾 T 細胞的代謝，所以此方法還是有其極限。

科學專題常識問答比賽(科 CEPT)問題精選答案

1. C. Ⅰ、Ⅳ、Ⅶ
   具體的稀土金屬包括：鑭、鈰、鐠、釹、鉕、釤、銪、釓、鋱、鏑、鈥、鉺、銩、鐿以及與鑭系的 15 個元素密切相關的兩個元素—鈧和釔。

2. A. Ⅰ、Ⅱ
   根據稀土元素原子電子層結構和物理化學性質，以及它們在礦物中共生情況和不同的離子半徑可產生不同性質的特徵，十七種稀土元素通常分為二組：
   輕稀土包括：鑭、鈰、鐠、釹、鉕、釤、銪、釓。
   重稀土包括：鋱、鏑、鈥、鉺、銩、鐿、鈧、釔。

3. B. 親代中至少一方須為白色
   當顯性基因和隱性基因一起存在時，顯性基因所決定的遺傳特徵就會表現出來，所以白色毛若為顯性，則親代中至少一方須為白色。

4. C. 使基因重組機會增加
   有性生殖的好處是遺傳信息的重組，這也是物種內遺傳信息的多樣性的由來。

Lunch Time Video Shows:12:20 p.m. @ Chem. Lab. (Room 512)

Date	Name of Program	Language / Subtitle	Area
10/1 (Mon)	Nature's Great Events - The Great Melt (Part I) 自然界大事件 - 大消融	Cantonese / Chinese	Biology 生物學
13/1 (Thu)	Nature's Great Events - The Great Melt (Part II) 自然界大事件 - 大消融	Cantonese / Chinese	Biology 生物學