comet's nucleus could destroy the spacecraft.

Among the eight scientific instruments now envisioned for the craft is a camera based on an 800-by-800-element charged-coupled device, the same size as the heart of the advanced camera being developed for NASA's Galileo Jupiter orbiter. Comet nuclei are hidden by gas and dust from earth-based observers, and ESA planners hope that their spacecraft's sophisticated sensor will be able to photograph details on Halley's nucleus as small as 50 meters across. Such pictures could reveal not only the nucleus's size, shape and brightness variations, but perhaps its rotation rate and the ways in which it gives off its dust, gas and ice in response to the sun's heat. Other instruments will include neutral, ion and dust mass spectrometers for composition measurements; a dust impact detector; an electron/ion plasma analyzer and magnetometer for studies of the comet's charged-particle environment; and an ultraviolet spectrometer for remote and *in situ* examination of the coma or cometary "atmosphere."

All of these experiments may end up under the aegis of European scientists, but many U.S. researchers would like a chance to take part, and to that end ESA has in effect provided a carrot: ESA's $116 million estimate for the mission's cost does not include the experiments (in Europe their funding comes with the participating scientists) but it does include the cost of a launching by ESA's Ariane rocket. ESA has invited NASA to provide (and pay for) a U.S. Delta rocket and launch services, as well as the ground stations of the Deep Space Network for tracking and data acquisition — "in return," says an ESA report on the mission, "for an appropriate share of the scientific payload." Without such cooperation, according to an ESA official, U.S. researchers might be able to take part only as members of teams under European leadership. This could affect the U.S. participants' ability to influence experimental goals and operations as well as instrument design.

This may not sound like the most open-armed approach to cooperative planning, but ESA may be applying the lessons of past experience. ESA had agreed to provide a probe that would have been sent to Halley's nucleus from a NASA-built flyby — until NASA failed to get its own part funded. Further money troubles caused NASA to delay its half of a NASA-ESA two-spacecraft mission to study the sun's poles (reducing the likelihood of concurrent observations), and similar woes have put off NASA funding connected with Spacelab, the ESA-built research module for the U.S. space shuttle. Nonetheless, NASA hopes to be able to take part in ESA's Halley mission (a decision is needed late this year), as well as to fly its own, aimed to reach the comet before perihelion to complement the ESA post-perihelion plan. □

Vertebrate sans O_2: Fishbowl fermenter

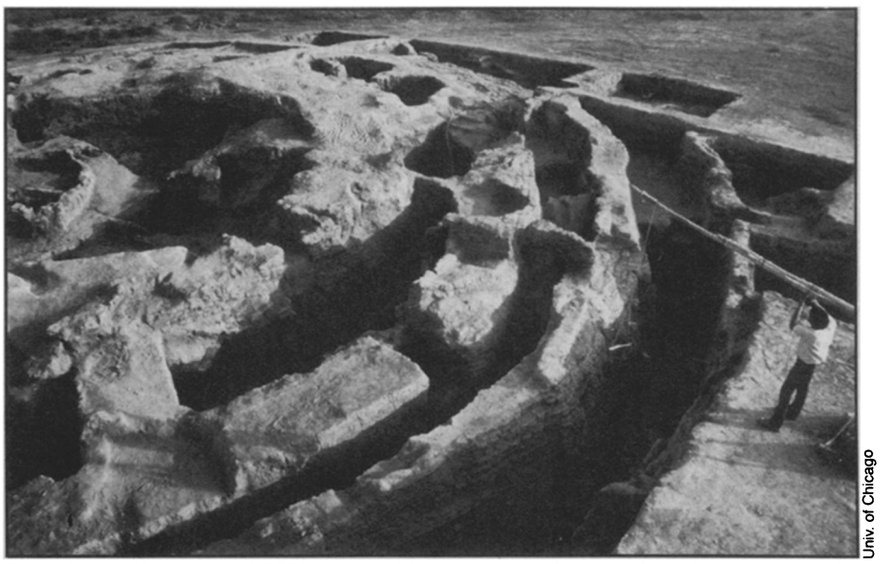
The common goldfish has a not-so-common talent: At low temperatures, it can survive several days in the complete absence of oxygen. Although the precise basis for this capability remains unknown, researchers recently reported that the fish's survival in anaerobic conditions may depend, to a large extent, on its production of ethanol — a two-carbon alcohol.

"The goldfish has evolved a novel pathway of vertebrate anaerobic metabolism in which glucose carbon is metabolized to ethanol," report P.W. Hochachka and colleagues of the University of British Columbia at Vancouver in the July 11 SCIENCE.

In other vertebrates, when glucose is broken down for energy under anaerobic conditions — during violent muscular activity, for example, when the energy need is greater than that supplied by aerobic respiration — lactic acid is produced. The accumulation of this lactic acid in the goldfish bloodstream, however, would be risky business, Hochachka and colleagues report.

The vertebrate bloodstream is equipped with buffer systems designed to maintain a constant pH. Normally, one major buffer system is the carbon dioxide (CO_2)-bicarbonate (HCO_3^-) equilibrium: $CO_2 + H_2O \rightarrow HCO_3^- + H^+$. But because the large volume of water that passes over the fish's gills acts as a CO_2 sink, draining the fish of its CO_2 supply, the goldfish has a poor CO_2-HCO_3^- buffer system. If the goldfish — with such an inadequate buffer system — were to rely on conventional anaerobic glucose breakdown, then lactic acid build-up would result in a debilitative disturbance of its pH. Anaerobic production of the neutral ethanol seems to have evolved to compensate the fish's poor buffer system. □

Landmark architecture: Found and lost



Univ. of Chicago

Enough remains intact of 5,000-year-old fortress to confirm that it had a vaulted roof.

You dig and sift and search in a race against time, but you know all along that you can't win. The site you are working will be obliterated by a high-rise building, by pipeline construction or by the waters rising behind a new dam. This is the frustration of salvage archaeology, but there can be rewards — especially if you make an important find. And that's what is being claimed by archaeologists excavating a soon-to-be-flooded site in the Hamrin Basin of northern Iraq. Teams from the Oriental Institute of the University of Chicago and from the University of Copenhagen have found a 5,000-year-old round fortress with a vaulted roof made of mudbrick. It is one of the earliest known vaulted roofs (parts of which are still intact), and McGuire Gibson of the Oriental Institute says the building is a landmark in architectural history. Mudbrick, he adds, is an unusual substance for a monumental building of this type.

The fortress, which is strategically located on what was the most important thoroughfare for trade, warfare and travel between Mesopotamia and the East, indicates that fortified settlements existed much earlier than had been suspected. The main structure (27 meters high with 4-meter-high, buttressed walls) contained stone implements, flint sickle blades and copper tools and weapons along with hundreds of fragments of a distinctive pottery that was used to date the settlement.

Because the structure is made of mudbrick, the vault cannot be removed and preserved as an architectural landmark. The waters are expected to cover it late this year or early next year. □