## Frozen embryo grows to healthy calf

Three weeks ago, a healthy calf was born to a cross Hereford-Friesian cow at the Agricultural Research Council's Unit of Reproductive Physiology and Biochemistry at Cambridge, England. It is the first large mammal to be born after being deep-frozen as an embryo, thawed and implanted into the uterus of a foster mother.

Twenty-two eggs were introduced into 11 cows nine months ago at the Cambridge unit. All the eggs came from cows fertilized by artificial insemination. The eggs were removed 10 days after pregnancy and frozen to minus 196 degrees C. (the temperature of liquid nitrogen) for six days. Only two eggs became implanted in the uterus of a foster mother, both in the same cow, but one died *in utero*.

Failure of the other 20 embryos is attributed to damage done during the freezing and thawing processes. According to biologist Ian Wilmut, a researcher at Cambridge, it is probable that vital cells were damaged in the unsuccessful attempts while only replaceable cells were killed in the successful attempt. The formation of ice crystals is the major problem involved in freezing animal tissue.

Similar freezing experiments with mice were performed last summer by researchers at the Oak Ridge National Laboratory in Tennessee. They found that embryos exposed to dimethylsulphoxide, a cryoprotective (antifreeze) agent and cooled at 0.3 to 2.0 degrees C. per minute gave the best chances of survival. The bull embryos were cooled at 0.2 degrees C. per minute. Thawing also has to be done very slowly.

Future experiments will involve varying four factors—the stage of development at which the embryo is removed from its mother, the rate at which the embryo is frozen, the rate at which the embryo is thawed and the medium in which it is frozen.

If perfected, the technique could be of enormous importance for not only the commercial livestock industry but also for genetic research. The technique could make it possible to store entire genomes in liquid nitrogen, at little cost, indefinitely. Already, sperms can be stored, but they contain only half the genome.

Secondly, if perfected commercially, cows, who give valuable milk but produce too skinny calves for beef, might be impregnated with embryos of beefier breeds.

Lastly, it might be possible to send entire herds of cattle and other livestock to far corners of the world in nitrogen flasks. □

## How plants and animals survive in the desert

For thousands of years plants and animals have lived in the desert. Only in recent years, though, have biologists grasped some of the challenges that desert life faces. Only today, with superior instruments and methods of inquiry, are biologists really finding out how different desert organisms adapt to their environment.

If there is anything plant scientists are learning, it is that lack of water is the major problem confronting desert plants. And desert plants have various means of adapting to lack of water, M. Evenari of the Hebrew University of Jerusalem reported last week at the annual meeting of the American Institute of Biological Sciences. Evenari has studied desert plants in Israel for 40 years.

Dew is desert plants' main source of water, the Israeli plant physiologist says. Desert plants are able to grow roots rapidly. They can take up water instantly. Most intriguingly, they regulate their body size according to the amount of water available. Apparently they take information from the soil about water that is available, then pass this information on up their stems.

Desert plants also adapt to lack of water through their stomates, I. P. Ting of the University of California reported at the AIBS meeting. Stomates are tiny openings in leaves that allow leaves to exchange gases with the air. Desert plants have sunken stomates, so that when the stomates are open, a minimal amount of water is lost through them. But desert plants go a step further to reduce water loss through their stomates. They open their stomates at night only. This means that part of photosynthesis is carried out at night. Photosynthesis is the process whereby plants take carbon dioxide from the air and water from the soil, and with the help of sunlight, convert them into sugar.

What happens, the Riverside, Calif., plant physiologist explains, is that when desert plants open their stomates at night, carbon dioxide passes through the stomates into the leaves. There it is converted into a four-carbon compound. The four-carbon compound is stored in the leaves until daytime. It is then converted into a three-carbon compound, the product of conventional photosynthesis, and then on into sugar.

But desert plants pay a price for these adaptations. "Growth of desert plants," Evenari says, "is zero or next to zero."

Lack of water is also a major problem for desert animals. Hoofed mammals that live in the desert have several means of adaptation, C. R. Taylor of Harvard University reported at the AIBS meeting. The African antelope and gazelle get almost all their water needs by grazing on plants at night, when the water content of plants is high. Desert ungulates also have a slower metabolism than do nondesert ungulates, which permits them to excrete less urine, feces and other body fluids and thereby conserve water. Desert ungulates can also cool off without losing water. Nondesert hoofed mammals cannot do so.

Domestic ungulates kept in the desert, such as the zebu cattle in Africa, are watered frequently and are corralled at night. They often die. Taylor suggests that such domestic ungulates might be left to graze at night and be watered less frequently. This way they might better survive desert conditions.

Desert reptiles and amphibians have one survival mechanism in common: they can tolerate water loss up to 25 to 50 percent of their body weight. Beyond that, however, they usually differ in their adaptations to lack of water, Vaughan Shoemaker of the University of California reported at the AIBS meeting.

Most amphibians burrow in sand so that they avoid, rather than prevent, water loss. Reptiles stay above ground during the day and survive torpid heat because their skins prevent water loss. Recently several species of frogs have been found in the desert that have skins that prevent water loss. One such species was discovered by the Riverside, Calif., animal physiologist in Argentina.

This frog, Shoemaker says, "makes a skin cover at the drop of a hat." He evaluated the cover as a barrier to water loss. At first water loss was as high as for a nondesert frog. But by the third or fourth day the frog cover was significantly reducing water loss. The cover looks, to the naked eye, like a big insect cocoon. Under the electron microscope, it looks like layers of cells. Other investigators, however, believe that the cover may be made of mucous secretions rather than of cell layers. No one yet knows what it is in reptile skin that prevents water loss.

Amphibians do not drink, but get water through their skin from the soil. Reptiles may also take up water through their skin. One Australian lizard was thought to take up water through the skin. Then little channels were found on its skin that led water to its mouth, where the water was ingested.

Amphibians may be able to hold urine until they get enough water to excrete it. Such a mechanism would help prevent water loss. Reptiles excrete nitrogen as urate salts, which minimizes water loss. Says Shoemaker, "We know little about what governs the formation of these salts." □