Frogs survive the freeze in recent organ implant research

By GISELLE WINTON

The day when human hearts, kidneys and livers are frozen, thawed and then implanted into human recipients may not be far off said one speaker at the Biological Tolerance to Environmental Stress symposium held at York on March 2.

The topic of animals' tolerance to freezing was discussed by Dr. Kenneth B. Storey, of the Department of Biology at Carleton University. Six speakers from Canada and the United States discussed how various plants and animals cope with natural deviances in their environment.

Recently scientists have discovered that some frogs can survive whole-body freezing, which may be an important find because frogs are multiorganed like man, Dr. Storey explained to a small but attentive audience at the graduate biology symposium.

The "trick" to frogs surviving freezing is that at negative eight degrees celsius for five days, only their blood freezes. In most animals their cells freeze, causing death.

Remarkably, all the constituents involved in the frog's freezing 'metabolic pathway' are found in our own bodies.

Crystal formation is the trigger to this special metabolic pathway. At negative one degree celsius, as soon as the first ice crystal forms in the frog's blood, further crystal formation increases 500-1,000 fold. This stimulates a mass production of glucose. The glucose is most abundant in the liver tissues, and it is the source of energy for the body. The liver converts glycogen (a storage energy form) to glucose, an active energy form, during the freezing.

The survival of the frozen froggies, however, is limited by the accumulation of lactate in the tissues. A derivative of this, lactic acid, is responsible for the pain an athlete feels during vigorous exercise.

The thawing of the frogs is slow. "It takes hours before the heart begins to beat," Dr. Storey says. "Then the frog wakes up and hops away."

Insects have a greater freezing tolerance, freezing at negative eight degrees celsius, and being able to survive temperatures down to minus 40 celsius, he said. In the wild they freeze and thaw daily with temperature fluctuations. In this way it has been determined by Dr. Storey and his associates that they could survive a year-and a half of winter; obviously much more than necessary. Again lactate is the limiting factor to the length of freezing time, Storey said.

"There is a possibility of saving our lakes through selenium (an element) addition to the water, Dr. J.F. Heisinger of the University of South Dakota said.

"Selenium provides protection against the toxic effects of mercury," he said. "It has been established in a wide variety of vertebrates, from fish to mammals and birds."

Fish were studied by Heisinger in the Creek and Missouri River. Since Custard led the first expedition to the area to discover gold over 100 years ago, 40 pounds per day of mercury has been dumped into the water. To the astonishment of Heisinger and his crew, the levels of mercury in the fish were low because of the naturally high level of selenium content in the river.

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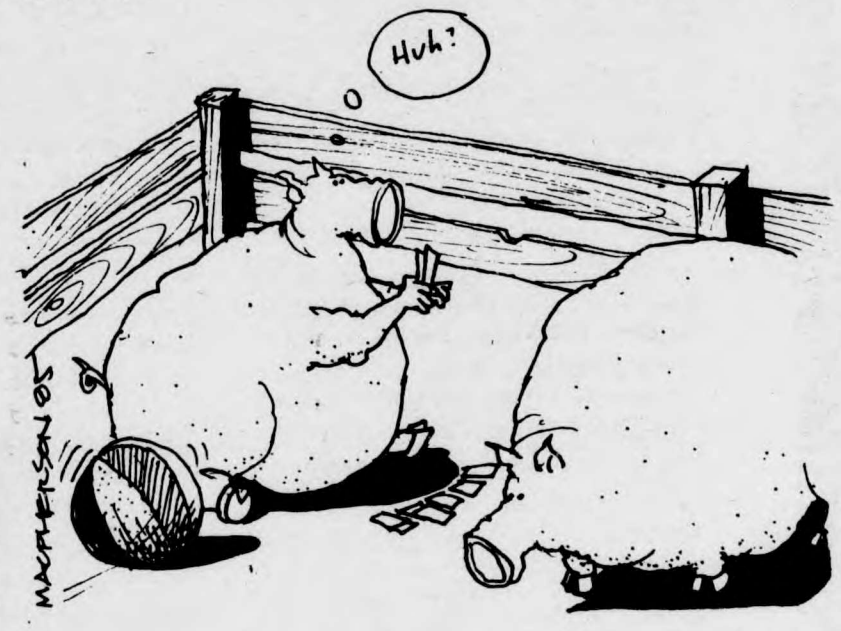
The broad breasted turkey is too broad to reproduce naturally. Its chest is just too heavy—it falls over.

"Altering the biology of an animal (domestic, such as cattle, pigs, chickens) for greater production affects the ability to reproduce," Dr. B.W. Kennedy of the University of Guelph says.



"In cows, stress of increased yield for milk production can affect the fitness of the animal . . . and this could impose a limit to selection for increased milk production. The solution to this problem probably lies in improved management of high producing cows in order to reduce stress associated with high production," Kennedy said.

"Beach balls have been thrown into a pig pen to give them something to do. It helps keep them happy and therefore reduces stress," says Dr. Kennedy.

Other methods of reducing stress are often costly and slow, such as slowing down the selection process or selecting for disease resistant animals. Crossbreeding is a method used to maintain a high degree of variation in the population in hopes that it will lower the frequency of disease.

Dr. Kennedy does not feel that milk production in cows has reached its genetic height.

"The threshold level (the level of which 50 percent of pollen produced by plants is killed by toxic substances) has been exceeded in Southern Ontario," says Dr. K.M. Cox, Maritime Forest Research Center.

The threshold level is ph6 (acidity increases with decreasing ph). Levels of ph4 and ph3 have been found in London and the St. Lawrence Vally.

Laboratory experiments performed by Dr. Cox and his associates determined that a ph level of 3.6 causes an almost total stoppage in pollen growth.

Sulphur dioxide—long range air pollutants that contain trace elements of metals—have been shown by Dr. Cox to reduce viability and quality, pollen germination and the receptivity of the plant's stigmas.

Reduced seed occurred "close to sources of pollution," said Dr. Cox, and this reduces its finess, which in turn affects future generations of the plant.

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Experiments conducted with birc and aspen trees in polluted areas indicated that the pollen was literally falling off the stigmas, demonstrating a reduction in their receptivity. This decreases the number of new seedlings.

Dr. Cox is currently investigating the effects of acid rain on seed production and quality. There are "not enough experiments" being conducted at the present to determine the full effects of pollution on plants, Dr. Cox said.

There is a set of genes that, when subjected to a temperature above normal physiological temperature, produce a set of proteins that "act to protect the organism from damage," says Dr. Milton Schlesinger of the Washington School of Medicine. These are termed "heat shock" genes.

They are "highly conserved," meaning they occur in virtually every organism "from the simplest bacteria to complex mammals," such as man. "Vertebrates subjected to febrile temperatures show a response analagous to those of simpler organisms," reports Dr. Schlesinger. This is significant because most of the research done in this area has been on *Drosophila* (fruitfly) and E. coli (a bacterium).

"Heat shock genes can also function to repair cell damage," says Schlesinger.